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# ESSAY

ON

# CALCAREOUS MANURES.

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*By Edmund Ruffin.*

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SECOND EDITION.

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SHELLBANKS, VA.

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# PREFACE.

THE object of this Essay is to investigate the peculiar features and qualities of the soils of our tide-water district, to show the causes of their general unproductiveness, and to point out means as yet but little used, for their effectual and profitable improvement. My observations are particularly addressed to the cultivators of that part of Virginia which lies between the sea coast and the falls of the rivers, and are generally intended to be applied only within those limits. By thus confining the application of the opinions which will be maintained, it is not intended to deny the propriety of their being further extended. On the contrary, I do not doubt but that they may correctly apply to all similar soils, under similar circumstances; for the operations of nature are conducted by uniform laws, and like causes must every where produce like effects. But as I shall rely for proofs on such facts as are either sufficiently well known already, or may easily be tested by any inquirer, I do not choose to extend my ground so far, as to be opposed by the assertion of other facts, the truth of which can neither be established nor overthrown by any available or sufficient testimony.

The peculiar qualities of our soils have been little noticed, and the causes of those peculiarities have never been sought—and though new and valuable truths may await the first explorers of this opening for agricultural research, yet they can scarcely avoid mistakes sufficiently numerous to moderate the triumph of success. I am not blind to the difficulties of the investigation, nor to my own unfitness to overcome them—nor should I have hazarded the attempt, but for the belief that such an investigation is all important for the improvement of our soil and agriculture, and that it was in vain to hope that it would be undertaken by those who were better qualified to do justice to the subject. I ask a deliberate hearing, and a strict scrutiny of my opinions, from those most interested in their truth. If a change, in most of our lands, from hopeless sterility to a high state of productiveness, is a vain fancy, it will be easy to discover and expose the fallacy of my views: but if these views are well founded, none better deserve the attention of farmers, and nothing can more seriously affect the future agricultural prosperity of our country. No where ought such improvements to be more highly valued, or more eagerly sought, than among us, where so many causes have concurred to reduce our products, and the prices of our lands, to the lowest state, and are yearly extending want, and its consequence, ignorance, among the cultivators and proprietors.

In pursuing this inquiry, it will be necessary to show the truth of various facts and opinions, which as yet are unsupported by authority, and most of which have scarcely been noticed by agricultural writers, unless to be denied. The number of proofs that will be required, and the discursive course through which they must be reached, may probably render more obscure the reasoning of an unpractised writer. Treatises on agriculture ought to be so written as to be clearly understood, though it should be at the expense of some other requisites of good writing—and in this respect, I shall be satisfied if I succeed in making my opinions intelligible to every reader, though many might well dispense with such particular explanations. Agricultural works are seldom considered as requiring very close attention; and therefore, to be made useful, they should be put in a shape suited to cursory and irregular reading. A truth may be clearly established—but if its important consequences cannot be regularly deduced for many pages afterwards, the premises will then probably have been forgotten, so that a very particular reference to them may be required. These considerations must serve as my apology for some repetitions—and for minute explanations and details, which some readers may deem unnecessary.

The theoretical opinions supported in this essay, together with my earliest experiments with calcareous manures, were published in the American Farmer, (vol. 3. page 313,) in 1821. No reason has since induced me to retract any of the important positions then assumed. But the many imperfections in that publication, which grew out of my want of experience, made it my duty, at some future time, to correct its errors, and supply the deficiencies of proof, from the fruits of subsequent practice and observation. With these views, this essay was commenced and finished in 1826. But the work had so grown on my hands, that instead of being of a size suitable for insertion in an agricultural journal, it would have filled a volume. The unwillingness to assume so conspicuous a position, as the publication in that form would have required, and the fear that my work would be more likely to meet with neglect or censure than applause, induced me to lay it aside, and to give up all intention of publication. Since that time, the use of fossil shells as a manure has greatly increased, in my own neighborhood and elsewhere, and has been attended generally with all the improvement and profit that was expected. But from paying no regard to the theory of the operation of this manure, and from not taking warning from the known errors and losses of myself as well as others, most persons have used it injudiciously, and have damaged more or less of their lands. So many disasters of this kind, seemed likely to restrain the use of this valuable manure, and even to destroy its reputation, just as it was beginning rapidly to extend. The additional consideration has at last induced me to risk the publication of this essay.

The experience of five more years, since it was written, has not contradicted any of the opinions then advanced—and no change has been made in the work, except in form, and by continuing the reports of experiments to the present time.

It should be remembered, that my attempt to convey instruction is confined to a single means of improving our lands, and increasing our profits: and though many other operations are, from necessity, incidentally noticed, my opinions or practices on such objects are not referred to as furnishing rules for good husbandry. In using calcareous manure for the improvement of poor soils, my labors have been highly successful—but that success is not necessarily accompanied by general good management and economy. To those who know me intimately, it would be unnecessary to confess the small pretensions that I have to the character of a good farmer—but to others, it may be required, for the purpose of explaining why other improvements and practices of good husbandry have not been more aided by, and kept pace with, the effects of my use of calcareous manures.

E. R.

*Shellbanks, Virginia, January 20th,* 1834.

# ADVERTISEMENT

## To Second Edition.

When the first edition of this Essay was published, it met with a reception far more favorable, and a demand from purchasers much greater, than the author's anticipations had reached: and it is merely in accordance with the concurrent testimony of the many agriculturists who have since expressed and published opinions on the subject, to say that the publication has already had great and valuable effects in directing attention, and inducing successful efforts, to the improvement of land by calcareous manures. Experimental knowledge on this head has probably been more than doubled within the last two years; and the narrow limits of the region within which marling had previously been confined, have been enlarged to perhaps tenfold their former extent. Still, the circumstances now existing, however changed for the better, present a mere beginning of the immense and valuable improvements of soil, and increase of profits, that must hereafter grow out of the use of calcareous manures, *if their operation is properly understood by those who apply them.* But if used without that knowledge, their great value will certainly not be found; and indeed, they will often cause more loss than profit. It is therefore not so important to the farmers of our country at large to be convinced of the general and great value of calcareous manures—and to those in the great Atlantic tide-water region to know the newly established truth, that their beds of fossil shells furnish the best and cheapest of manures—as it is, that all should know in what manner, and by what general laws, these manures operate—how they produce benefit, and when they may be either worthless, or injurious. And this more important end, the author regrets to believe has as yet scarcely been even partially attained, by the dissemination and proper understanding of correct views of the subject. Of course it is not to be supposed that this Essay has been read, (if even heard of,) by one in ten of the many who have been prompted by verbal information, to attempt the practice it recommends; and of those who have read, and who have even expressed warm approbation of the work, it has seldom been found that their praise was discriminating, or founded upon a thorough examination of its reasoning and theoretical views, on which, whatever value it may possess, principally rests. For all persons who are so easily convinced, it may be truly said, that the volume embraced nothing more, and was worth no more, than would be found in these few words—"the application of calcareous manures will be found highly improving and profitable." It is not therefore at all strange, that the attentive reading of a volume to obtain this truth, was generally deemed unnecessary.

Though the first edition of this work has been nearly exhausted, the circulation has as yet been almost confined to a small portion of only the state of Virginia, in which the mode of improvement recommended had previously been successfully commenced, or had at least attracted much attention. But this district is not better fitted to be thus improved than the remainder of the great tide-water region, stretching from Long Island to Mobile—and to a great part of which, calcareous manures may be cheaply applied. It is only in parts of Maryland and Virginia that many extensive and highly profitable applications of fossil shells, or marl, have

been yet made: in North Carolina, the value of the manure has been but lately tried—in South Carolina and Georgia, no notice of it has been yet taken, or at least has not been made known—and in Florida and Alabama, (parts of which are peculiarly suited to receive these benefits,) it is most erroneously thought that such improvements are only profitable for old settled and impoverished countries. The farmers of Pennsylvania have gone far ahead of those in Virginia in manuring with lime—and it is believed (but upon no certain testimony) that in New Jersey, use has been made of the calcareous manure which in Virginia is called marl, as well as of the *green sand*, which they even still more erroneously call by the same name. But whatever may have been the extent of their use of calcareous manures of every kind, and however great their success, it is believed that our northern brethren have been as little directed by correct views of the operation of these manures, as those of the south, who have neglected them entirely.

But though the circulation of this work will be most useful through the great tide-water region, which is so generally supplied with underlying beds of fossil shells, and so much of the soil of which especially needs such manure--still the assertion may be ventured that there is no part of the country, where the views presented, *if true*, are not important to be known—and if known, would not be highly useful to aid the improvement of soils. It is to the general theory of the constitution of fertile and barren soils, that the attention and severe scrutiny of both scientific and practical agriculturists are invited—and to the several minor points there presented, which are either altogether new, or not established by authority: such as the doctrine of acidity in soils—of the incapacity of poor and acid soils to be enriched—and of the entire absence of carbonate of lime in most of the soils of this country.

The circumstances stated above, have induced the publication of a second edition as a supplement to the Farmers' Register, (and suited to be bound with either volume of that work,) which, in that form, may have the facility of distribution through the mail—and which may be offered at so low a price as to reach, as nearly as possible, that general circulation which is its author's main object.

This edition will contain nearly three-fourths more print than the first, (each page of this, containing as much as four and a half pages of that,) and yet will be sold at but little more than half the price. The new matter consists principally of more full explanations—additional and new proofs—and more full and minute directions for practical operations, designed especially for the use of those who are beginning to apply marl, and have every thing on the subject to learn.

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# ESSAY

ON

# CALCAREOUS MANURES.

## PART I—*Theory.*

### CHAPTER I.

GENERAL DESCRIPTION OF EARTHS AND SOILS.

It is very necessary that we should correctly distinguish *earths* and *soils* and their many varieties: yet these terms are continually misapplied—and even among authors of high authority, no two agree in their definitions, or modes of classification. Where such differences exist, and no one known method is so free from material imperfections, as to be referred to as a common standard, it becomes necessary for every one who treats of soils, to define for himself—though perhaps he is thereby adding to the general mass of confusion already existing. This necessity must be my apology for whatever is new or unauthorized in the following definitions.

The *earths* important to agriculture, and which form nearly the whole of the known globe, are only three—*silicious aluminous*, and *calcareous*.

*Silicious earths*, in its state of absolute purity, forms rock crystal. The whitest and purest sand may be considered as silicious earth in agriculture, though none is presented by nature entirely free from other ingredients. It is composed of very hard particles, not soluble in any common acid, and which cannot be made coherent by mixing with water. Any degree of coherence, or any shade of color that sand may exhibit, is owing to the presence of other substances. The solidity of the particles of sand renders them impenetrable to water, which passes between them as through a sieve. The hardness of its particles, and their loose arrangement, make sand incapable of absorbing moisture from the atmosphere, or of retaining any valuable vapor or fluid, with which it may have been in any manner supplied. Silicious earth is also quickly heated by the sun, which adds to the rapidity with which it loses moisture.

*Aluminous* or *argillaceous earth*, when dry, adheres to the tongue, absorbs water rapidly and abundantly, and when wet, forms a tough paste, smooth and soapy to the touch. By burning it becomes as hard as stone. Clays derive their adhesiveness from their proportion of aluminous earth. This also is white when pure, but is generally colored deeply and variously—red, yellow, or blue—by metallic substances. When drying, aluminous earth shrinks greatly—it becomes a mass of very hard lumps, of various sizes, separated by cracks and fissures, which become so many little reservoirs of standing water, when filled by rains, and remain so, until the lumps, by slowly imbibing the water, are distended enough to fill the space occupied before.

*Calcareous earth*, or *carbonate of lime*,* is *lime* combined with *carbonic acid*, and may be converted into pure or quick-lime by heat—and quick-lime, by exposure to the air, soon returns to its former state of calcareous earth. It forms marble, limestone, chalk, and shells, with very small admixtures of other substances. Thus the term *calcareous earth* will not be used here to include either *lime* in its pure state, or any of the numerous combinations which lime forms with the various acids, except that one (carbonate of lime) which is beyond comparison the most abundant throughout the world, and most important as an ingredient of soils. Pure lime attracts all acids so powerfully, that it is never presented by nature except in combination with some one of them, and generally with the carbonic acid. When this compound is thrown into any stronger acid, as muriatic, nitric, or even strong vinegar—the lime being more powerfully attracted, unites with, and is dissolved by the stronger acid, and lets go the carbonic, which escapes, with effervescence, in the form of air. In this manner, the carbonate of lime, or calcareous earth, may not only be easily distinguished from silicious, and aluminous earth, but also from all other combinations of lime. [See Appendix A.†]

* *Carbonate of lime* is the chemical name for the substance formed by the combination of *carbonic acid* with *lime*. The names of all the thousands of different substances (*neutral salts*) which are formed by the combination of each of the many acids with each of the various earths, alkalis, and metals, are formed by one uniform rule, which is as simple and easy to be understood and remembered, as it is useful. To avoid repeated explanations in the course of this essay, the rule will now be stated by which these compounds are named. The termination of the name of the acid is changed to the syllable *ate*, and then prefixed to the particular earth, alkali, or metal with which the acid is united. With this explanation, any reader can at once understand what is meant by each of some thousands of terms, none of which might have been heard of before, and which (without this manner of being named) would be too numerous to be fixed in the most retentive memory. Thus, it will be readily understood that the *carbonate of magnesia* is a compound of the carbonic acid and magnesia—the *sulphate of lime*, a compound of sulphuric acid and lime—the *sulphate of iron*, a compound of sulphuric acid and iron—and in like manner for all other terms so formed.

† The note referred to in the appendix A, will supply some remarks and explanations which a scientific reader would correctly consider as a deficiency if entirely omitted, but which, if added to the text above,

Calcareous earth in its different forms has been supposed to compose as much as one-eighth part of the crust of the globe.* Very extensive plains in France and England are of chalk, pure enough to be nearly barren, and to prove that pure calcareous earth would be entirely so. No chalk is to be found in our country—and it is only from European authors that we can know any thing of its agricultural characters, when nearly pure, or when forming a very large proportion of the surface of the land. The whiteness of chalk repels the rays of the sun, while its loose particles permit water to pass through, as easily as sand:† and thus calcareous earth is remarkable for possessing some of the worst qualities of both the other earths, and which it serves to cure in them (as will hereafter be shown) when used as a manure.

Most of those who have applied chemistry to agriculture, consider *magnesia* as one of the important earths.‡ Magnesia, like lime, is never found pure, but always combined with some acid, and its most general form is the carbonate of magnesia. But even in this, its usual and natural state, it exists in such very small quantities in soils, and is found so rarely, that its name seems a useless addition to the list of the earths of agriculture. For all practical purposes, gypsum (though only another combination of lime,) would more properly be arranged as a distinct earth, or element of soils, as it is found in far greater abundance and purity, and certainly affects some soils and plants in a far more important manner than has yet been attributed to magnesia, in its natural form.

All the earths, when as pure as they are ever furnished by nature, are entirely barren, as might be inferred from the description of their qualities: nor would any addition of putrescent manures§ enable either of the earths to support healthy vegetable life.

The mixture of the three earths in due proportions, will correct the defects of all, and with a sufficiency of animal or vegetable matter, putrescent, and soluble in water, a *soil* is formed in which plants can extend their roots freely, yet be firmly supported, and derive all their needful supplies of air, water, and warmth, without being oppressed by too much of either. Such is the natural surface of almost all the habitable world: and though the qualities and value of soils are as various as the proportions of their ingredients are innumerable, yet they are mostly so constituted, that no one earthly ingredient is so abundant, but that the texture¶ of the soil is mechanically suited to some one valuable crop—as some plants require a degree of closeness, and others of openness in the soil, which would cause other plants to decline or perish.

Soil seldom extends more than a few inches below the surface, as on the surface only are received those natural supplies of vegetable and animal matters, which are necessary to constitute soil. Valleys subject to inundation have soils brought from higher lands, and deposited by the water, and therefore are of much greater depth. Below the soil is the *subsoil*, which is also a mixture of two or more earths, but is as barren as the unmixed earths, because it contains very little putrescent matter, the only food for plants.

The qualities and value of soils depend on the proportions of their ingredients. We can easily comprehend in what manner silicious and aluminous earths, by their mixture, serve to cure the defects of each other—the open, loose, thirsty, and hot nature of sand being corrected by, and correcting in turn, the close, adhesive, and water holding qualities of aluminous earth. This curative operation is merely mechanical—and in that manner it seems likely that calcareous earth, when in large proportions, also acts, and aids the corrective powers of both the other earths. This however is only supposition, as I have met with scarcely any such natural soil.

But besides the mechanical effects of calcareous earth, (which perhaps are weaker than those of the other two,) that earth has chemical powers far more effectual in altering the texture of soils, and for which a comparatively small quantity is amply sufficient. The chemical action of calcareous earth as an ingredient of soils, will be fully treated of hereafter: it is only mentioned in this place to avoid the apparent contradiction which might be inferred, if, in a general description of calcareous earth, I had omitted all allusion to qualities that will afterwards be brought forward as all important.

It seems most proper to class and name soils according to their *predominant* earthy ingredients, by which term, I mean those ingredients which exert the greatest power, and most strongly mark the character of the soil. The predominant ingredient (in this sense,) is not always the most abundant, and frequently is the least. If the most abundant was considered the predominant ingredient, and gave its name to the soil,* then almost every one should be called silicious, as that earth is seldom equalled in quantity by all the others united. If the earthy parts of a soil were two-thirds silicious, and one-third of aluminous earth, the peculiar qualities of the smaller ingredient would predominate over the opposing qualities of the sand, and the mixture would be a tenacious clay. If the same soil had contained only one-twentieth part of calcareous earth, that ingredient would have had more marked effects on the soil, than could have been produced by either doubling, or diminishing to half their quantity, the silicious and aluminous earths, which formed the great bulk of the soil. If soils were named according to certain proportions of their ingredients, (as proposed by Davy,†) a correct, though limited ana-

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would have been useless and perhaps embarrassing to readers in general.

* Cleaveland's Mineralogy—On Carbonate of Lime.

† Cours Complet d'Agriculture, etc. par l'Abbé Rozier—*Terres.*

‡ Davy's Agr. Chem. page 110. Phil. Ed. 1821.

§ *Putrescent or enriching manures*, are those formed of vegetable and animal matters, capable of putrefying, and thereby furnishing soluble food to plants. Farm-yard and stable manure, and the weeds and other growth of the fields left to die and rot on them, are almost the only enriching manures that have been used as yet in this country.

¶ The *texture* of a soil means the disposition of its parts, which produces such sensible qualities, as being close, adhesive, open, friable, &c.

* Which is the plan of the nomenclature of soils proposed by Rozier—See article "*Terres,*" Cours Complet d'Agriculture, etc. † Agr. Chem. p. 139.

lysis of a soil would be required, before its name or character could be given—and even then the name and character would often disagree. But every farmer can know what are the most marked good or bad qualities of his soils, as shown under tillage, and those qualities can be easily traced to their predominant ingredients. By compounding a few terms, various shades of difference may be designated with sufficient precision. A few examples will be sufficient to show how all may be applied:—

A *silicious* or *sandy soil* has such a proportion of silicious earth as to show more of its peculiar properties than those of any other ingredient. It would be more or less objectionable for its looseness, heat, and want of power to retain either moisture or putrescent manure—and not for toughness, liability to become hard after wet ploughing, or any other quality of aluminous earth.

In like manner, an *aluminous* or *clayey soil*, would show most strongly the faults of aluminous earth, though more than half its bulk might be of silicious.

The term *loam* is not essential to this plan, but it is convenient, as it will prevent the necessity of frequent compounds of other terms. It will be used for all soils formed with such proportions of sand and aluminous earth, as not to be light enough to be called sandy, nor stiff enough for clay soil. *Sandy loam* and *clayey loam* would express its two extremes—and *loamy sand* would be still lighter than the former, and *loamy clay* stiffer than the latter.

In all compound names of soils, the last term should be considered as expressing the predominant earthy ingredient. Thus, a *sandy loamy calcareous soil*, would be nearer to loam than sand, and more marked by its calcareous ingredient than either. Other ingredients of soils besides the earths, or any accidental or rare quality affecting their character considerably, may be described with sufficient accuracy by such additional terms as these—a *ferruginous gravelly silicious loam*—or a *vegetable calcareous clay*. [Appendix B.]

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## CHAPTER II.

### ON THE SOILS, AND STATE OF AGRICULTURE OF THE TIDE-WATER DISTRICT OF VIRGINIA.

————"During several days of our journey, no spot was seen that was not covered with a luxuriant growth of large and beautiful forest trees, except where they had been destroyed by the natives for the purpose of cultivation. The least fertile of their pasture lands, without seeding, are soon covered with grass several feet in height; and unless prevented by cultivation, a second growth of trees rapidly springs up, which, without care or attention, attain their giant size in half the time that would be expected on the best lands in England."——

If the foregoing description was met with in a "Journey through Hindoostan," or some equally unknown region, no European reader would doubt but such lands were fertile in the highest degree—and even many of ourselves would receive the same impression. Yet it is no exaggerated account of the poorest natural soils in our own poor country, which are as remarkable for their producing luxuriant growths of pines, and broom grass, as for their unproductiveness in every cultivated or valuable crop. We are so accustomed to these facts, that we scarcely think of their singularity; nor of the impropriety of calling any land barren, which will produce a rapid growth of any one plant. Indeed, by the rapidity of that growth, (or the fitness of the soil for its production,) we have in some measure formed a standard of the poverty of the soil.

With some exceptions to every general character, the tide-water district of Virginia may be described as generally level, sandy, poor, and free from any fixed rock, or any other than stones rounded apparently by the attrition of water. On much the greater part of the lands, no stone of any kind is to be found, of larger size than gravel. Pines of different kinds form the greater part of a heavy cover to the silicious soils in their virgin state, and mix considerably with oaks, and other growth of clay land. Both these kinds of soil, after being exhausted of their little fertility by cultivation, and "turned out" to recruit, are soon covered by young pines which grow with vigor and luxuriance. This general description applies more particularly to the *ridges* which separate the *slopes* on different streams. The ridge lands are always level, and very poor—sometimes clayey, more generally sandy, but stiffer than would be inferred from the proportion of silicious earth they contain, which is caused by the fineness of its particles. Whortleberry bushes, as well as pines, are abundant on ridge lands—and numerous shallow basins are found, which are ponds of rain water in winter, but dry in summer. None of this large proportion of our lands, has paid the expense of clearing and cultivation, and much the greater part still remains under its native growth. Enough however has been cleared and cultivated in every neighborhood, to prove its utter worthlessness, under common management. The soils of ridge lands vary between sandy loam, and clayey loam. It is difficult to estimate their general product under cultivation; but judging from my own experience of such soils, the product may be from five bushels of corn, or as much of wheat, to the acre, on the most clayey soils, to twelve bushels of corn, and three of wheat on the most sandy —if wheat were there attempted to be made.

The *slopes* extend from the ridges to the streams, or to the alluvial bottoms, and include the whole interval between neighboring branches of the same stream. This class of soils forms another great body of lands—of a higher grade of fertility, though still far from valuable. It is generally more sandy than the poorer ridge land, and when long cultivated, is more or less deprived of its soil, by the washing of rains, on every slight declivity. The washing away of three or four inches in depth, exposes a steril subsoil (or forms a "gall") which continues thenceforth bare of all vegetation: a greater declivity of the surface serves to form gullies several feet in depth, the earth carried from which, covers and injures the adjacent lower land. Most of this kind of land has been cleared, and greatly exhausted. Its virgin growth is often more of oak, hickory, and dogwood, than pine—but when turned out of cultivation, an unmixed growth of pine follows. Land

of this kind in general has very little durability; its usual best product of corn may be for a few crops, eighteen or twenty bushels—and even as much as twenty-five bushels, from the highest grade. Wheat is seldom a productive or profitable crop on the slopes, the soil being generally too sandy. When such soils as these are called rich or valuable (as most persons would describe them,) those terms must be considered as only comparative—and such an application of them proves that truly fertile and valuable soils, are very scarce in Lower Virginia.

The only very rich and durable soils below the falls of our rivers, are narrow strips of highland along their banks, and the lowlands formed by the alluvion of the numerous smaller streams which water our country. These alluvial bottoms, though highly productive, are lessened in value by being generally too sandy, and by the damage they suffer from being often inundated by floods of rain. The best highland soils seldom extend more than half a mile from the river's edge—sometimes not fifty yards. These irregular margins are composed of loams of various qualities, but all highly valuable; and the best soils are scarcely to be surpassed, in their original fertility, and durability under severe tillage. Their nature and peculiarities will be again adverted to, and more fully described hereafter.

The simple statement of the general course of tillage to which our part of the country has been subjected, is sufficient to prove that great impoverishment of the soil has been the inevitable consequence. The small portion of rich river margins, was soon all cleared, and was tilled without cessation for many years. The clearing of the slopes was next commenced, and is not yet entirely completed. On these soils, the succession of crops was less rapid, or from necessity, tillage was sooner suspended. If not rich enough for tobacco when first cleared, (or as soon as it ceased to be so,) land of its kind was planted in corn two or three years in succession, and afterwards every second year. The intermediate year between the crops of corn, the field was "rested" under a crop of wheat, if it would produce four or five bushels to the acre. If the sandiness, or exhausted condition of the soil, denied even this small product of wheat, that crop was probably not attempted—and instead of it, the field was exposed to close grazing, from the time of gathering one crop of corn, to that of preparing to plant another. No manure was applied, except on the tobacco lots; and this rotation of a grain crop every year, and afterwards every second year, was kept up as long as the field would produce five bushels of corn to the acre. When reduced below that product, and to less than the necessary expense of cultivation, the land was turned out to recover under a new growth of pines. After twenty or thirty years, according to the convenience of the owner, the same land would be again cleared, and put under similar scourging tillage, which however would then much sooner end, as before, in exhaustion. Such a general system is not yet every where abandoned—and many years have not passed, since such was the usual course on almost every farm.

How much our country has been impoverished during the last fifty years, cannot be determined by any satisfactory testimony. But however we may differ on this head, there are but few who will not concur in the opinion, that our system of cultivation has been every year lessening the productive power of our lands in general—and that no one county, no neighborhood, and but few particular farms, have been at all enriched, since their first settlement and cultivation. Yet many of our farming operations have been much improved within the last fifteen or twenty years. Driven by necessity, proprietors direct more personal attention to their farms—better implements of husbandry are used—every process is more perfectly performed—and whether well or ill directed, a spirit of inquiry and enterprise has been awakened, which before had no existence.

Throughout the country below the falls, and perhaps thirty miles above, if the best land be excluded, say one-tenth, the remaining nine-tenths will not yield an average product of ten bushels of corn to the acre; though that grain is best suited to our soils in general, and far exceeds in quantity all other kinds raised. Of course, the product of a large proportion of the land, would fall below this average. Such crops, in very many cases, cannot remunerate the cultivator. If our remaining woodland could be at once brought into cultivation, the *gross* product of the country would be greatly increased, but the *net* product very probably diminished—as the general poverty of these lands would cause more expense than profit to accompany their cultivation under the usual system. Yet every year we are using all our exertions to clear woodland, and in fact seldom increase either net or gross products—because nearly as much old exhausted land is turned out of cultivation as is substituted by the newly cleared. Sound calculations of profit and loss, would induce us to reduce the extent of our present cultivation, by turning out every acre that yields less than the total cost of its tillage.

No political truth is better established than that the population of every country will increase, or diminish, according to its regular supply of food. We know from the census of 1830, compared with those of 1820 and 1810, that our population is nearly stationary, and in some counties, is actually lessening; and therefore it is certain, that our agriculture is not increasing the amount of food, or the means of purchasing food—with all the assistance of the new land annually brought under culture. In these circumstances, a surplus population, with all its deplorable consequences, is only prevented by the great current of emigration which is continually flowing westward. No matter who emigrates, or with what motive—the enterprising or wealthy citizen who leaves us to seek richer lands and greater profits, and the slave sold and carried away on account of his owner's poverty, concur in producing the same result, though with very different degrees of benefit to those who remain. If this great and continued drain from our population was stopped, and our agriculture was not improved, want and misery would work to produce the same results. Births would diminish, and deaths would increase—and hunger and disease would keep down population to that number, that the average products of our agricultural and other labor could feed, and supply with other means of living.

A stranger to our situation and habits might well oppose to my statements the very reasonable bjection, that no man would, or could, long pur-

sue a system of cultivation of which the returns fell short of his expenses, including rent of land, hire of labor, interest on the necessary capital, &c. Very true—if he had to pay those expenses out of his profits, he would soon be driven from his farm to a jail. But we own our land, our laborers, and stock—and though the calculation of net profit, or of loss, is precisely the same, yet we are not ruined by making only two per cent. on our capital, provided we can manage to live on that income. If we live on still less, we are actually growing richer (by laying up a part of our two per cent.,) notwithstanding the most clearly proved regular loss on our farming.

Our condition has been so gradually growing worse, that we are either not aware of the extent of the evil, or are in a great measure reconciled by custom to profitless labor. No hope for a better state of things can be entertained, until we shake off this apathy—this excess of contentment which makes no effort to avoid existing evils. I have endeavored to expose what is worst in our situation as farmers: if it should have the effect of rousing any of my countrymen to a sense of the absolute necessity of some improvement, to avoid ultimate ruin, I hope also to point out to some of their number, if not to all, that the means for certain and highly profitable improvements, are completely within their reach. [Appendix C.]

## CHAPTER III.

### THE DIFFERENT CAPACITIES OF SOILS FOR RECEIVING IMPROVEMENT.

As far as the nature of the subjects permitted, the foregoing chapters have been merely explanatory and descriptive. The same subjects will be resumed and more fully treated in the course of the following argument, the premises of which, are the facts and circumstances that have been detailed. What I wish to prove will be stated in a series of propositions, which will now be presented at one view, and afterwards separately discussed in their proper order.

Proposition 1. Soils naturally poor, and rich soils reduced to poverty by cultivation, are essentially different in their powers of retaining putrescent manures: and under like circumstances, the fitness of any soil to be enriched by these manures, is in proportion to what was its natural fertility.

2. The natural sterility of the soils of Lower Virginia is caused by such soils being destitute of calcareous earth, and their being injured by the presence and effects of vegetable acid.

3. The fertilizing effects of calcareous earth are chiefly produced by its power of neutralizing acids, and of combining putrescent manures with soils, between which there would otherwise be but little if any chemical attraction.*

4. Poor and acid soils cannot be improved durably, or profitably, by putrescent manures, without previously making them calcareous, and thereby correcting the defect in their constitution.

5. Calcareous manures will give to our worst soils a power of retaining putrescent manures, equal to that of the best—and will cause more productiveness, and yield more profit, than any other improvement practicable in Lower Virginia.

Dismissing from consideration, for the present, all the others, I shall proceed to maintain the

### FIRST PROPOSITION.

*Soils naturally poor, and rich soils reduced to poverty by cultivation, are essentially different in their powers of retaining putrescent manures: and under like circumstances, the fitness of any soil to be enriched by these manures, is in proportion to what was its natural fertility.*

The *natural fertility* of a soil is not intended to be estimated by the amount of its earliest product, when first brought under cultivation, because several temporary causes then operate either to keep down, or to augment the product. If land be cultivated immediately after the trees are cut down, the crop is greatly lessened by the numerous living roots, and consequent bad tillage—the excess of unrotted vegetable matter, and the coldness of the soil, from which the rays of the sun had been so long excluded. On the other hand, if cultivation is delayed one or two years, the leaves and other vegetable matters are rotted, and in the best state to supply food to plants, and are so abundant, that a far better crop will be raised than could have been obtained before, or perhaps will be again, without manure. For these reasons, the degree of natural fertility of any soil should be measured by its products after these temporary causes have ceased to act, which will generally take place before the third or fourth crop is gathered. According, then, to this definition, a certain degree of permanency in its early productiveness, is necessary to entitle a soil to be termed *naturally fertile*. It is in this sense, that I deny to any poor lands, except such as were naturally fertile, the capacity of being made rich by putrescent manures only.

The foregoing proposition would by many persons be so readily admitted as true, that attempting to prove it would be deemed entirely superfluous. But many others will as strongly deny its truth, and can support their opposition by high agricultural authorities.

General readers, who may have no connexion with farming, must have gathered from the incidental notices in various literary works, that some countries or districts that were noted for their uncommon fertility or barrenness, as far back as any accounts of them have been recorded, still retain the same general character, through every change of policy, government, and even of the race of

* When any substance is mentioned as *combining* with one or more other substances, as different manures with each other, or with soil, I mean that a union is formed by chemical attraction, and not by simple mixture. *Mixtures* are made by mechanical means, and may be separated in like manner; but *combinations* are chemical, and require some stronger chemical attraction, to take away either of the bodies so united.

When two substances combine, they both lose their previous peculiar qualities, or *neutralize* them for each other, and form a third substance different from both. Thus, if certain known proportions of muriatic acid, and pure or caustic soda, be brought together, their strong attraction will cause them to combine immediately. The strong corrosive acid quality of the one, and the equally peculiar alkaline taste and powers of the other, will *neutralize* or entirely destroy each other—and the compound formed, is common salt, the qualities of which are as strongly marked, but totally different from those of either of its constituent parts.

inhabitants. They know that for some centuries at least, there has been no change in the strong contrast between the barrenness of Norway, Brandenburg, and the Highlands of Scotland, and the fertility of Lombardy and Valencia. Sicily, notwithstanding its government is calculated to discourage industry, and production of every profitable kind, still exhibits that fertility for which it was celebrated two thousand years ago. It seems a necessary inference from the many statements of which these are examples, that the labors of man have been but of little avail in altering permanently the characters and qualities given to soils by nature.

Most of our experienced practical cultivators, through a different course, have arrived at the same conclusion. Their practice has taught them the truth of this proposition—and the opinions thus formed have profitably directed their most important operations. They are accustomed to estimate the worth of land by its natural degree of fertility —and by the same rule they are directed on what soils to bestow their scanty stock of manure, and where to expect exhausted fields to recover by rest, and their own unassisted powers. But content with knowing the fact, this useful class of farmers have never inquired for its cause—and their opinions on this subject, as on most others, have not been communicated so as to benefit others.

But if all literary men who are not farmers, and all practical cultivators who seldom read, admitted the truth of my proposition, it would avail but little for improving our agricultural operations—and the only prospect of its being usefully disseminated, is through that class of farmers who have received their first opinions of improving soils, from books, and whose subsequent plans and practices have grown out of those opinions. If poor natural soils cannot be durably or profitably improved by putrescent manures, this truth should not only be known, but be kept constantly in view, by every farmer who can hope to improve with success. Yet it is a remarkable fact, that the difference in the capacities of soils for receiving improvement, has not attracted the attention of scientific farmers—and the doctrine has no direct and positive support from the author of any treatise on agriculture, English or American, that I have been able to consult. On the contrary, it seems to be considered by all of them, that to collect and apply as much vegetable and animal manure as possible, is sufficient ro ensure profit to every farmer, and fertility to every soil. They do not tell us that numerous exceptions to that rule will be found, and that many soils of apparent good texture, if not incapable of being enriched from the barn-yard, would at least cause more loss than clear profit, by being improved from that source.

When it is assumed that the silence of every distinguished author as to certain soils being incapable of being profitably enriched, amounts to ignorance of the fact, or a tacit denial of its truth—it may be objected that the exception was not omitted from either of these causes, but because it was established and undoubted. This is barely possible: but even if such was the case, their silence has had all the ill consequences that could have grown out of a positive denial of any exceptions to the propriety of manuring poor soils. Every zealous young farmer, who draws most of his knowledge and opinions from books, adopts precisely the same idea of their directions—and if he owns barren soils he probably throws away his labor and manure for their improvement, for years, before experieuce compels him to abandon his hopes, and acknowledge that his guides have led him only to failure and loss. Such farmers as I allude to, by their enthusiasm and spirit of enterprise, are capable of rendering the most important benefits to agriculture. Whatever may be their impelling motives, the public derives nearly all the benefit of their successful plans—and their far more numerous misdirected labors, and consequent disappointments, are productive of national, still more than individual loss. The occurrence of only a few such mistakes, made by reading farmers, will serve to acquit me of combating a shadow—and there are few of us who cannot recollect some such examples.

But if the foregoing objection has any weight in justifying European authors in not naming this exception, it can have none for those of our own country. If it is admitted that soils naturally poor are incapable of being enriched with profit, that admission must cover three-fourths of all the high-land in the tide-water district. Surely no one will contend that so sweeping an exception was silently understood by the author of *Arator*, as qualifying his exhortations to improve our lands: and if no such exception was intended to be made, then will his directions for enriching soils, and his promises of reward, be found equally fallacious, for the greater portion of the country, to benefit which his work was specially intended. The omission of any such exception by the writers of the United States, is the more remarkable, as the land has been so recently brought under cultivation, that the original degree of fertility of almost every farm may be known to its owner, and compaired with the after progress of exhaustion or improvement.

Many authorities might be adduced to prove that I have correctly stated what is the fair and only inference to be drawn from agricultural books, respecting the capacity of poor soils to receive improvement. But a few of the most strongly marked passages in Arator will be fully sufficient for this purpose. The venerated author of that work was too well acquainted with the writings of European agriculturists, to have mistaken their doctrines in this important particular. A large portion of his useful life was devoted to the successful improvement of exhausted, but originally fertile lands. His instructions for producing similar improvements are expressly addressed to the cultivators of the eastern parts of Virginia and North Carolina, and are given as applicable to all our soils, without exception. Considering all these circumstances, the conclusions which are evidently and unavoidably deduced from his work, may be fairly considered, not only as supported by his own experience, but as concurring with the general doctrine of improving poor soils, maintained by previous writers.

At page 54, third edition of Arator, "*inclosing*" (i. e. leaving fields to receive their own vegetable cover, for their improvement during the years of rest,) is said to be "the most powerful means of fertilizing the earth"—and the process is declared to be rapid, the returns near, and the gain great.

Page 61. "If these few means of fertilizing

"the country [cornstalks, straw, and animal dung,] "were skilfully used, they would of themselves "suffice to change its state from sterility to fruit-"fulness."—"By the litter of Indian corn, and of "small grain, and of penning cattle, managed "with only an inferior degree of skill, in union "with inclosing, I will venture to affirm that a "farm may in ten years be made to double its "produce, and in twenty to quadruple it."

No opinions could be more strongly or unconditionally expressed than these. No reservation or exception is made. I may safely appeal to each of the many hundreds who attempted to obey these instructions, to declare whether any one considered his own naturally poor soils excluded from the benefit of these promises—or whether a tithe of that benefit was realized on any farm composed generally of such soils. In a field of mine that has been secured from grazing since 1814, and cultivated on the four shift rotation, the produce of a marked spot has been measured every fourth year (when in corn) since 1820. The difference of product has been such as the differences of season might have caused—and the last crop (in 1828) was worse than those of either of the two preceding rotations. There is no reason to believe that even the smallest increase of productive power has taken place.

It is far from my intention, by these remarks, to deny the propriety, or to question the highly beneficial results, of applying the system of improvement recommended by Arator, to soils originally fertile. On the contrary, it is as much my object to maintain the facility of restoring to worn lands their natural degree of fertility, by vegetable applications, as it is to deny the power of exceeding that degree, however low it may have been.

One more quotation will be offered, because its recent date and the source whence it is derived, furnish the best proof that it is still the received opinion among agricultural writers, that all soils may be profitably improved, by putrescent manures. An article in the *American Farmer*, of October 14th, 1831, on "manuring large farms," by the editor, contains the following expressions. "————By proper exertions, every farm in the "United States can be manured with less expense "than the surplus profits arising from the manure "would come to. This we sincerely believe, and "we have arrived at this conclusion from long "and attentive observation. We never yet saw "a farm that we could not point to means of ma-"nuring, and bring into a state of high and pro-"fitable cultivation at an expense altogether in-"considerable when contrasted with the advan-"tages to be derived from it." The remainder of the article shows that putrescent manures are principally relied on to produce these effects: marsh and swamp mud are the only kinds referred to that are not entirely putrescent in their action, and mud certainly cannot be used to manure every farm. Mr. Smith, having been long the conductor of a valuable agricultural journal, as a matter of course, is extensively acquainted with the works and opinions of the best writers on agriculture; and therefore, his advancing the foregoing opinions, as certain and undoubted, is as much a proof of the general concurrence of preceding writers, as if the same had been given as a digest of their precepts.

Some persons will readily admit the great difference in the capacities of soils for improvement, but consider a deficiency of clay only to cause the want of power to retain manures. The general excess of sand in our poor lands might warrant this belief in a superficial and limited observer. But though clay soils are more rarely met with, they present, in proportion to their extent, full as much poor land. The most barren and worthless soils in the county of Prince George, are also the stiffest. A poor clay soil, will retain manure longer than a poor sandy soil—but it will not the less certainly lose its acquired fertility at a somewhat later period. When it is considered that a much greater quantity of manure is required by clay soils, it may well be doubted whether the improvement of the sandy soils would not be attended with more profit—or more properly speaking, with less actual loss.

It is true that the capacity of a soil for improvement is greatly affected by its texture, shape of the surface, and its supply of moisture. Dry, level, clay soils, will retain manure longer, than if they were sandy, hilly, or wet. But however important these circumstances may be, neither the presence or absence of any of them can cause the differences of capacity for improvement. There are rich and valuable soils with one or more of all these faults—and there are soils the least capable of receiving improvement, free from objection as to their texture, degree of moisture, or inclination of their surface. Indeed the great body of our poor ridge lands, is more free from faults of this kind, than soils of far greater productiveness usually are. Unless then some other and far more powerful obstacle to improvement exists, why should not all our woodland be highly enriched, by the hundreds, or thousands, of crops of leaves which have successively fallen and rotted there? Notwithstanding this vegetable manuring, which infinitely exceeds all that the industry and patience of man can possibly equal, most of our woodland remains poor—and this one fact (which at least is indisputable,) ought to satisfy all of the impossibility of enriching such soils by putrescent manures only. Some few acres may be highly improved, by receiving all the manure derived from the offal of the whole farm—and entire farms, in the neighborhood of towns, may be kept rich by continually applying large quantities of purchased manures. But no where can a farm be found, which has been improved beyond its original fertility, by means of the vegetable resources of its own arable fields. If this opinion is erroneous, nothing is easier than to prove my mistake, by adducing undoubted examples of such improvements having been made.

But a few remarks will suffice on the capacity for improvement of worn lands, which were originally fertile. With regard to these soils, I have only to concur in the received opinion of their fitness for durable and profitable improvement by putrescent manures. After being exhausted by cultivation, they will recover their productive power, by merely being left to rest for a sufficient time, and receiving the manure made by nature, of the weeds and other plants that grow and die upon the land. Even if robbed of the greater part of that supply, by the grazing of animals, a still longer time will serve to obtain the same result. The better a soil was at first, the sooner it will recover by these means, or by artificial manuring. On

soils of this kind, the labors of the improving farmer meet with success and reward—and whenever we hear of remarkable improvements of poor land by putrescent manures, further inquiry will show us that these poor lands had once been rich.

The continued fertility of certain countries for hundreds or even thousands of years, does not prove that the land could not be, or had not been, exhausted by cultivation: but only that it was slow to exhaust and rapid in recovering—so that whatever repeated changes may have occurred in each particular tract, the whole country taken together always retained a high degree of productiveness. Still the same rule will apply to the richest and the poorest soils—that each exerts strongly a force to retain as much fertility as nature gave them—and that when worn and reduced, each may easily be restored to its original state, but cannot be raised higher, with either durability or profit by putrescent manures, whether applied by the bounty of nature, or the industry of man.

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## CHAPTER IV.

### EFFECTS OF THE PRESENCE OF CALCAREOUS EARTH IN SOILS.

PROPOSITION 2. *The natural sterility of the soils of Lower Virginia is caused by such soils being destitute of calcareous earth, and their being injured by the presence and effects of vegetable acid.*

The means which would appear the most likely to lead to the causes of the different capacities of soils for improvement, is to inquire whether any known ingredient or quality is always to be found belonging to improvable soils, and never to the unimprovable—or which always accompanies the latter, and never the former kind. If either of these results can be obtained, we will have good ground for supposing that we have discovered the general cause of fertility, in the one case—or of barrenness, in the other: and it will follow, that if we can supply to barren soils the deficient beneficial ingredient—or can destroy that which is injurious to them—that their incapacity for receiving improvement will be removed. All the common ingredients of soils, as sand, clay, or gravel—and such qualities as moisture or dryness—a level, or a hilly surface—however they may affect the value of soils, are each sometimes found exhibited in a remarkable degree, in both the fertile and the steril. The abundance of putrescent vegetable matter might well be considered the cause of fertility, by one who judged only from lands long under cultivation. But though vegetable matter in sufficient quantity is essential to the existence of fertility, yet will this substance also be found inadequate, as its cause. Vegetable matter abounds in all rich land, it is admitted; but it has also been furnished by nature, in quantities exceeding all computation, to the most barren soils we own.

But there is one ingredient of which not the smallest proportion can be found in any of our poor soils, and which, wherever found, indicates a soil remarkable for natural and durable fertility. This is *calcareous earth*. These facts alone, if sustained, will go far to prove that this earth is the cause of fertility, and the cure for barrenness.

On some part of most farms touching tidewater, either muscle or oyster shells are found mixed with the soil. Oyster shells are confined to the lands on salt water, where they are very abundant, and sometimes extend through large fields. Higher up the rivers, muscle shells only are to be seen thus deposited by nature, and they decrease as we approach the falls of the rivers. The proportion of shelly land in the counties highest on tide-water, is very small—but the small extent of these spots does not prevent, but rather aids, the investigation of the peculiar qualities of such soils. Spots of shelly land, not exceeding a few acres in extent, could not well have been cultivated differently from the balance of the fields of which they formed parts—and therefore they can be better compared with the worse soils under like treatment. Every acre of shelly land is, or has been, remarkable for its richness, and still more for its durability. There are few farmers among us who have not heard described tracts of shelly soil on Nansemond and York Rivers, which are celebrated for their long resistance of the most exhausting system of tillage, and which still remain fertile, notwithstanding all the injury which they must have sustained from their severe treatment. We are told that on some of these lands, corn has been raised every successive year, without any help from manure, for a longer time than the owners could remember, or could be informed of, correctly. But without relying on any such remarkable cases, there can be no doubt but that every acre of our shelly land has been at least as much tilled, and as little manured, as any in the country; and that it is still the richest and most valuable of all our old cleared land.

The fertile but narrow strips along the banks of our rivers, (which form the small portion of our highland of first rate quality,) seldom extend far without exhibiting spots in which shells are visible, so that the eye alone is sufficient to prove the soil of such places to be calcareous. The similarity of natural growth, and of all other marks of character are such, that the observer might very naturally infer that the former presence of shells had given the same valuable qualities to all these soils—but that they had so generally rotted, and been incorporated with the other earths, that they remained visible only in a few places, where they had been most abundant. The accuracy of this inference will hereafter be examined.

The natural growth of the shelly soils, (and of those adjacent of similar value,) is entirely different from that of the great body of our lands. Whatever tree thrives well on the one, is seldom found on the other class of soils—or if found, it shows plainly by its imperfect and stunted condition, on how unfriendly a soil it is placed. To the rich river margins are almost entirely confined the black or wild locust, hackberry or sugar nut tree, and papaw. The locust is with great difficulty eradicated, or the newer growths kept under on cultivated lands; and from the remarkable rapidity with which it springs up, and increases in size, it forms a serious obstacle to the cultivation of the river banks. Yet on the woodland only a mile or two from the river, not a locust is to be seen. On shelly soils, pines and broom grass cannot thrive, and are rarely able to maintain even the most sickly growth.

Some may say that these striking differences of

growth do not so much show a difference in the constitution of the soils, as in their state of fertility—or that one class of the plants above named delights in rich, and the other, in poor land. No plant prefers poor to rich soil—or can thrive better on a scarcity of food, than with an abundant supply. Pine, broom grass, and sorrel, delight in a class of soils that are generally unproductive—but not on account of their poverty—for all these plants show, by the greater or less vigor of their growth, the abundance or scarcity of vegetable matter in the soil. But on this class of soils, no quantity of vegetable manure could make locusts flourish, though they will grow rapidly on a calcareous hill-side, from which all the soil capable of supporting other plants, has been washed away.

In thus describing and distinguishing soils by their growth, let me not be understood as extending those rules to other soils and climates than our own. It is well established that changes of kind in successive growths of timber have occurred in other places, without any known cause—and a difference of climate will elsewhere produce effects, which here would indicate a change of soil.

Some rare exceptions to the general fertility of shelly lands are found where the proportion of calcareous earth is in great excess. Too much of this ingredient causes even a greater degree of sterility than its total absence. This cause of barrenness is very common in France and England (on chalk soils,) and very extensive tracts are not worth the expense of cultivation, or improvement. The few small spots that are rendered barren here, are seldom (if ever) so affected by the excess of oyster or muscle shells in the soil. These effects generally are caused by beds of fossil sea shells, which in some places reach the surface, and are thus exposed to the plough. These spots are not often more than thirty feet across, and their nature is generally evident to the eye; and if not, is so easily determined by chemical tests, as to leave no reason for confounding the injurious and beneficial effects of calcareous earth. This exception to the general fertilizing effect of this ingredient of our soils, would scarcely require naming, but to mark what might be deemed an apparent contradiction. But this exception, and its cause, must be kept in mind, and considered as always understood and admitted throughout all my remarks, and which therefore it is not necessary to name specially, when the general qualities of calcareous earth are spoken of.

In the beginning of this chapter, I advanced the important fact that none of our poor soils contain naturally the least particle of calcareous earth. So far, this is supported merely by my assertion—and all those who have studied agriculture in books, will require strong proof before they can give credit to the existence of a fact, which is either unsupported, or indirectly denied, by all written authority. Others, who have not attended to such descriptions of soils in general, may be too ready to admit the truth of my assertion—because, not knowing the opinions on this subject heretofore received and undoubted, they would not be aware of the importance of their admission.

It is true that no author has said expressly that every soil contains calcareous earth. Neither has any one stated that every soil contains some silicious, or aluminous earth. But the manner in which each has treated of soils and their constituent parts, would cause their readers to infer, that neither of these three earths is ever entirely wanting—or at least that the entire absence of the calcareous, is as rare as the absence of silicious or aluminous earth. Nor are we left to gather this opinion solely from indirect testimony, as the following examples, from the highest authorities, will prove. Davy says, "four earths generally abound in soils, the aluminous, the silicious, the calcareous, and the magnesian"*—and the soils of which he states the constituent parts, obtained by chemical analysis, as well as those reported by Kirwan, and by Young, all contain some proportion (and generally a large proportion) of calcareous earth.† Kirwan states the component parts of a soil which contained thirty-one per cent. of calcareous earth, and he supposes that proportion neither too little nor too much.‡ Young mentions soils of extraordinary fertility containing seventeen and twenty per cent., besides others with smaller proportions of calcareous earth—and says that Bergman found thirty per cent. in the best soil he examined.¶ Rozier speaks still more strongly for the general diffusion, and large proportions of this ingredient of soils. In his general description of earths and soils, he gives examples of the supposed composition of the three grades of soils which he designates by the terms *rich*, *good*, and *middling soils:* to the first class he assigns a proportion of one-tenth, to the second, one-fourth, and to the last, one-half of its amount, of calcareous earth. The fair interpretation of the passage is that the author considered these large proportions as general, in France—and he gives no intimation of any soil entirely without calcareous earth.§

American writers also suppose the general presence of this ingredient of soil: but their opinions on this subject are merely echos of European descriptions of soils. They seem neither to have suspected that so important a difference existed, nor to have made the least investigation by actual analysis, to sustain the false character thus given to the soils of our country. [Appendix D.]

With my early impressions of the nature and composition of soils, derived from the general descriptions given in books, it was with surprise, and some distrust, that when first attempting to analyze soils, in 1817, I found most specimens destitute of calcareous earth. The trials were repeated with care and accuracy, on soils from various places—until I felt authorized to assert without

*Davy's Agr. Chem. Lecture 1.

† Agr. Chem. Lect. 4.—Kirwan on Manures—and Young's Prize Essay on Manures.

‡ Kirwan on Manures, article Clayey Loam.

¶ Young's Essay on Manures.

§ "*Composition of soils.* Examples of the various composition of soils: *Rich soil;* silicious earth, 2 parts; aluminous, 6; calcareous, 1; vegetable earth, [*humus*] 1; in all, 10 parts. *Good soil*—silicious, 3 parts; aluminous 4; calcareous 2½; vegetable earth, ½ of 1 part; in all, 10 parts. *Middling soil* [*sol mediocre;*] silicious, 4 parts; aluminous, 1; calcareous, 5 parts, less by some atoms of vegetable earth; in all, 10 parts. We see that it is the largest proportion of aluminous earth, that constitutes the greatest excellence of soils; and we know that independently of their harmony of composition, they require a sufficiency of depth."—From the article "*Terres,*" in the "Cour Complet d'Agriculture Pratique, etc. par L'Abbé Rozier, 1815.

fear of contradiction, that no naturally poor soil, below the falls of the rivers, contains the smallest proportion of calcareous earth. Nor do I believe that any exception to this peculiarity of constitution can be found in any poor soil above the falls: but though these are far more extensive and important in other respects, they are beyond the district within the limits of which I propose to confine my investigation.

These results are highly important, whether considered merely as serving to establish my proposition, or as showing a radical difference between most of our soils, and those of the best cultivated parts of Europe. Putting aside my argument to establish a particular theory of improvement, the ascertained fact of the universal absence of calcareous earth in our poor soils leads to this conclusion—that profitable as calcareous manures have been found to be in countries where the soils are generally calcareous in some degree, they must be far more so on our soils that are quite destitute of that necessary earth.

## CHAPTER V.

### RESULTS OF THE CHEMICAL EXAMINATIONS OF VARIOUS SOILS.

### Proposition 2. *Continued.*

The certainty of any results of chemical analysis would be doubted by most persons who have paid no attention to the means employed for such operations: and their incredulity will be the more excusable, when such results are reported by one knowing very little of the science of chemistry, and whose limited knowledge was gained without aid or instruction, and was sought solely with the view of pursuing this investigation. Appearing under such disadvantages, it is therefore the more incumbent on me to show my claim to accuracy, or so to explain my method, as to enable others to detect its errors, if any exist. To analyze a specimen of soil completely, requires an amount of scientific acquirement and practical skill, to which I make no pretension. But merely to ascertain the absence of calcareous earth—or if present, to find its quantity—requires but little skill, and less science.

The methods recommended by different agricultural chemists for ascertaining the proportion of calcareous earth in soils, agree in all material points. Their process will be described, and made as plain as possible. A specimen of soil of convenient size is dried, pounded, and weighed, and then thrown into muriatic acid, diluted with three or four times its quantity of water. The acid combines with, and dissolves the *lime* of the calcareous earth, and its other ingredient, the *carbonic acid,* being disengaged, rises through the liquid in the form of *gas*, or air, and escapes with effervescence. After the mixture has been well shaken, and has stood until all effervescence is over, (the fluid still being somewhat acid to the taste, to prove that enough acid had been used, by some excess being left,) the whole is poured into a piece of blotting paper folded so as to fit within a glass funnel. The fluid containing the dissolved lime passes through the paper, leaving behind the clay and silicious sand, and any other solid matter; over which pure water is poured and passed off several times, so as to wash off all remains of the dissolved lime. These filtered washings are added to the solution, to all of which is then poured a solution of *carbonate of potash.* The two dissolved salts thus thrown together, (*muriate of lime,* composed of muriatic acid and lime—and *carbonate of potash,* composed of carbonic acid and potash,) immediately decompose each other, and form two new combinations. The muriatic acid leaves the lime, and combines with the potash, for which it has a stronger attraction—and the muriate of potash thus formed, being a soluble salt, remains dissolved and invisible in the water. The lime and carbonic acid being in contact, when let loose by their former partners, instantly unite, and form *carbonate of lime,* or calcareous earth, which being insoluble, falls to the bottom, is separated by filtering paper, is washed, dried and weighed, and thus shows the proportion contained by the soil.*

In this process, the carbonic acid which first composed part of the calcareous earth, escapes into the air, and another supply is afterwards furnished from the decomposition of the carbonate of potash. But this change of one of its ingredients does not alter the quantity of the calcareous earth, which is always composed of certain invariable proportions of its two component parts; and when all the lime has been precipitated as above directed, it will necessarily be combined with precisely its first quantity of carbonic acid.

This operation is so simple, and the means for conducting it so easy to obtain, that it will generally be the most convenient mode for finding the proportion of calcareous earth in those manures that are known to contain it abundantly, and where an error of a few grains cannot be very material. But if a very accurate result is necessary, this method will not serve, on account of several causes of error which always occur. Should no calcareous earth be present in a soil thus analyzed, the muriatic acid will take up a small quantity of aluminous earth, which will be precipitated by the carbonate of potash, and without further investigation, would be considered as so much calcareous earth. And if any compounds of lime and vegetable acids are present, (which for reasons hereafter to be stated, I believe to be not uncommon in soils,) some portion of them may be dissolved, and appear in the result as *carbonate* of lime, though not an atom of that substance was in the soil. Thus, every soil examined by this method of precipitation, will yield some small result of what would appear as calcareous earth, though actually destitute of such an ingredient. The inaccuracies of this method were no doubt known (though passed over without notice) by Davy, and other men of science who have recommended its use: but as they considered calcareous earth merely as one of the earthy ingredients of soil, operating mechanically, (as do sand and clay,) on the texture of the soil, they would scarcely suppose that a difference of a grain or two could materially affect the practical value of an analysis, or the character of the soil under examination.†

*More full directions for the analysis of soils may be found in Kirwan's Essay on Manures, Rozier's Dictionary, and Davy's Agricultural Chemistry: and of calcareous manures in Appendix E.

†"Chalks, calcareous marls, or powdered limestone

The pneumatic apparatus proposed by Davy,* as another means for showing the proportion of calcareous earth in soils, is liable to none of these objections; and when some other causes of error peculiar to this method, are known and guarded against, its accuracy is almost perfect, in ascertaining the quantity of calcareous earth—to which substance alone, its use is limited. The correctness of this mode of analysis depends on two well established facts in chemistry—1st. That the component parts of calcareous earth always bear the same proportion to each other—and these proportions are as forty-three parts (by weight) of carbonic acid, to forty-seven of lime. 2nd. That the carbonic acid gas which two grains of calcareous earth will yield, is equal in bulk to one ounce of fresh water. The process with the aid of this apparatus disengages, confines, and measures the gas evolved—and for every measure equal to the bulk of an ounce of water, the operator has only to allow two grains of calcareous earth in the soil acted on. It is evident that the result can indicate the presence of lime in no other combination except that which forms calcareous earth—nor of any other earth, except carbonate of magnesia, which, if present, might be mistaken for calcareous earth, but which is too rare, and occurs in proportions too small, to cause any material error.

But if it is only desired to know whether calcareous earth is entirely wanting in any soil—or to test the truth of my assertion that so great a proportion of our soils are destitute of that earth—it may be done with far more ease than by either of the foregoing methods, and without apparatus of any kind. Let a handful of the soil (without drying or weighing) be thrown into a large drinking glass, containing enough of pure water to cover the soil about two inches. Stir it until all the lumps have disappeared, and the water has certainly taken the place of all the atmospheric air which the soil had enclosed. Remove any vegetable fibres, or froth, from the surface of the liquid, so as to have it clear. Then pour in gently about a table spoonful of undiluted muriatic acid, which by its greater weight will sink, and penetrate the soil, without any agitation being necessary for that purpose. If any calcareous earth is present it will quickly begin to combine with the acid, throwing off its carbonic acid in *gas*, which cannot fail to be observed as it escapes, as the gas that only eight grains of calcareous earth would throw out, would be equal in bulk to a gill measure. Indeed, the product of only a single grain of calcareous earth, would be abundantly plain to the eye of the careful operator, though it might be the whole amount of gas from two thousand grains of soil. If no effervescence is seen even after adding more acid and gently stirring the mixture, then it is absolutely certain that the soil contained not the smallest portion of carbonate of lime—nor of the only other substance which might be mistaken for it, the carbonate of magnesia.

The examinations of all the soils that will be here mentioned, were made in the pneumatic apparatus, except some of those which evidently evolved no gas, and when no other result was required. As calcareous earth is plainly visible to the eye in all shelly soils, they only need examination to ascertain its proportion. A few examples will show what proportions we may find, and how greatly they vary, even in soils apparently of equal value.

1. Soil, a black clayey loam, from the top of the high knoll at the end of Coggin's Point, on James River, containing fragments of muscle shells throughout. Never manured and supposed to have been under scourging cultivation and close grazing from the first settlement of the country: then (1818) capable of producing twenty-five or thirty bushels of corn—and the soil well suited to wheat. One thousand grains, cleared by a fine sieve of all coarse shelly matter, (as none can act on the soil until minutely divided,) yielded sixteen ounce measures of carbonic acid gas, which showed the finely divided calcareous earth to be thirty-two grains.

2. One thousand grains of similar soil from another part of the same field, treated in the same manner, gave twenty-four grains of finely divided calcareous earth.

3. From the east end of a small island, at the end of Coggin's Point, surrounded by the river, and tide marsh. Soil, dark brown loam, much lighter than the preceding specimens, though not sandy—under like exhausting cultivation—then capable of bringing thirty to thirty-five bushels of corn—not a good wheat soil, ten or twelve bushels being probably a full crop. One thousand grains yielded eight grains of coarse shelly matter, and eighty-two of finely divided calcareous earth.

4. From a small spot of sandy soil, almost bare of vegetation, and incapable of producing any grain, though in the midst of very rich land, and cleared but a few years. Some small fragments of fossil sea shells being visible, proved this barren spot to be calcareous, which induced its examination. Four hundred grains yielded eighty-seven of calcareous earth—nearly twenty-two per cent. This soil was afterwards dug and carried out as manure.

5. Black friable loam, from Indian Fields, on York River. The soil was a specimen of a field of considerable extent, mixed throughout with oyster shells. Though light and mellow, the soil did not appear to be sandy. Rich, durable, and long under exhausting cultivation.

| | | |
|---|---|---|
| 1260 grains of soil yielded | | |
| 168 | — | of coarse shelly matter, separated mechanically, |
| 8 | — | finely divided calcareous earth. |

The remaining solid matter, carefully separated, (by agitation and settling in water,) consisted of

| | | |
|---|---|---|
| 130 grains | | of fine clay, black with putrescent matter, and which lost more than one-fourth of its weight by being exposed to a red heat, |
| 875 | — | white sand, moderately fine, |
| 20 | — | very fine sand, |
| 36 | — | lost in the process. |
| 1061 | | |

" *act merely by forming a useful earthy ingredient in the* " *soil*, and their efficacy is proportioned to the deficiency of calcareous matter, which in larger or smaller " quantities *seems to be an essential ingredient of all* " *fertile soils;* necessary *perhaps* to their proper texture, " and as an ingredient in the organs of plants." [Davy's Agr. Chem. page 21—and further on he says] "Chalk and marl or carbonate of lime *only improve the* " *texture of a soil, or its relation to absorption; it acts* " *merely as one of its earthy ingredients.*"

*See the plate and description in Lecture IV of Agricultural Chemistry.

6. Oyster shell soil of the best quality from the farm of Wills Cowper, Esq. on Nansemond River—never manured, and supposed to have been cultivated in corn as often as three years in four, since the first settlement of the country—now yields (by actual measurement) thirty bushels of corn to the acre—but is very unproductive in wheat. A specimen taken from the surface to the depth of six inches, weighed altogether

242 dwt., which consisted of

| | | |
|---|---|---|
| 126 | — | of shells and their fragments, separated by the sieve, |
| 116 | — | remaining finely divided soil. |

Of the finely divided part, 500 grains consisted of

| | | |
|---|---|---|
| 18 | grains | of carbonate of lime, |
| 330 | — | silicious sand—none very coarse, |
| 94 | — | impalpable aluminous and silicious earth, |
| 35 | — | putrescent vegetable matter—none coarse or unrotted, |
| 23 | — | loss. |
| 500 | | |

It is unnecessary to cite any particular trials of our poor soils, as it has been stated in the preceding chapter that all are entirely destitute of calcareous earth—excluding the rare, but well marked exceptions of its great excess, of which an example has been given in the soil marked 4, in the foregoing examinations.

Unless then I am mistaken in supposing that these facts are universally true, the certain results of chemical analysis completely establish these general rules—viz:

That all calcareous soils are naturally fertile and durable in a very high degree—and

That all soils naturally poor are entirely destitute of calcareous earth.

It then can scarcely be denied that calcareous earth must be the cause of the fertility of the one class of soils, and that the want of it produces the poverty of the other. Qualities that always thus accompany each other, cannot be otherwise than *cause* and *effect*. If further proof is wanting, it can be safely promised to be furnished when the practical application of calcareous manures to poor soils will be treated of, and their effects stated.

These deductions are then established as to all calcareous soils, and all poor soils—which descriptions comprise nine-tenths of all. This alone would open a wide field for the practical exercise of the truths we have reached. But still there remain strong objections and stubborn facts opposed to the complete proof of the proposition now under consideration, and consequently to the theory which that proposition is intended to support. The whole difficulty will be apparent at once when I now proceed to state that nearly all of our best soils, such as are very little if at all inferior in value to the small portion of shelly lands, are as destitute of calcareous earth as the poorest. So far as I have examined, this deficiency is no less general in the richest alluvial lands of the upper country—and, what will be deemed by some as incredible, by far the greater part of the rich limestone soils between the Blue Ridge and Alleghany Mountains are equally destitute of calcareous earth. These facts were not named before, to avoid embarrassing the discussion of other points—nor can they now be explained, and reconciled with my proposition, except through a circuitous and apparently digressive course of reasoning. They have not been kept out of view, nor slurred over, to weaken their force, and are now presented in all their strength. These difficulties will be considered, and removed, in the following chapters.

## CHAPTER VI.

### CHEMICAL EXAMINATION OF RICH SOILS CONTAINING NO CALCAREOUS EARTH.

PROPOSITION 2. *Continued.*

Under common circumstances, when any disputant admits facts that seem to contradict his own reasoning, such admission is deemed abundant evidence of their existence. But though now placed exactly in this situation, the facts admitted by me are so opposed to all that scientific agriculturists have taught us to expect, that it is necessary for me to show the grounds on which my admission rests. Few would have believed in the absence of calcareous earth in all our poor soils—and far more strange is it that the same deficiency should extend to such rich soils as some that will be cited.

The following specimens, taken from well known and very fertile soils, were found to contain no calcareous earth. Many trials of other rich soils have yielded like results—and indeed, I have never found calcareous earth in any soil below the falls of the rivers, in which, or near which, some particles of shells were not visible.

1. Soil from Eppes' Island, which lies in James River, near City Point; light and friable (but not silicious) brown loam, rich and durable. The surface is not many feet above the highest tides, and like most of the best river lands, this tract seems to have been formed by alluvion many ages ago, but which may be termed recent, when compared to the general formation of the tide-water district.

2. Black silicious loam from the celebrated lands on Back River, near Hampton.

3. Soil from rich land on Pocoson River, York County.

4. Black clay vegetable soil, from a fresh-water tide marsh on James River—formed by the most recent alluvion.

5. Alluvial soil of first rate fertility above the falls of James River—dark brown clay loam, from the valuable and extensive body of bottom land belonging to General J. H. Cocke, of Fluvanna.

The most remarkable facts of the absence of calcareous earth, are to be found in the limestone soils, between the Blue Ridge and Alleghany Mountains. Of these, I will report all that I have examined, and none contained any calcareous earth, unless when the contrary will be stated.*

* Before the first of these trials was made, I supposed (as probably most other persons do,) that *limestone soil* was necessarily *calcareous*, and in a high degree. It is difficult to get rid of this impression entirely—and it may seem a contradiction in terms to say that a *limestone soil* is not calcareous. This I cannot avoid: I must take the term *limestone soil* as cus

1 to 6. Limestone soils selected in the neighborhood of Lexington, Virginia, by Professor Graham, with the view of enabling me to investigate this subject. All the specimens were from first rate soils, except one, which was from land of inferior value. One of the specimens, Mr. Graham's description stated to be "taken from a piece of land so rocky [with limestone] as to be unfit for "cultivation—at least with the plough. I could "scarcely select a specimen which I would expect "to be more strongly impregnated with calcareous "earth." This specimen, by two separate trials, yielded only one grain of calcareous earth, from one thousand of soil. The other six soils contained none. The same result was obtained from

7. A specimen of alluvial land on North River, near Lexington.

8. Brown loam from the Sweet Spring Valley, remarkable for its extraordinary productiveness and durability. It is of alluvial formation, and before it was drained, must have been often covered and saturated by the Sweet Spring and other mineral waters, which hold lime in solution. The surrounding highland is of limestone soil. Of this specimen, taken from about two hundred yards below the Sweet Spring, from land long cultivated every year, three hundred and sixty grains yielded not a particle of calcareous earth. It contained an unusually large proportion of *oxide of iron*, though my imperfect means enabled me to separate and collect only eight grains, the process evidently wasting several more.

About a mile lower down, drains were then making (in 1826) to reclaim more of this rich valley from the overflowing waters. Another specimen was taken from the bottom of a ditch just opened, eighteen inches below the surface. It was a black loam, and exhibited to the eye some very diminutive fresh-water shells, (periwinkles, about one-tenth of an inch in length,) and many of their broken fragments. This gave, from two hundred grains, seventy-four of calcareous earth. But this cannot fairly be placed on the same footing with the other soils, as it had obviously been once the bottom of a stream, or lake, and the collection and deposite of so large and unusual a proportion of calcareous matter, seemed to be of animal formation. Both these specimens were selected at my request by one of our best farmers, and who also furnished a written description of the soils, and their situation.

9. Woodland, west of Union, Monroe County. Soil, a black clay loam, lying on, but not intermixed at the surface with limestone rock. Subsoil, yellowish clay. The rock at this place, a foot below the surface. Principal growth, sugar maple, white walnut, and oak. This and the next specimen are from one of the richest tracts of highland that I have seen.

10. Soil similar to the last and about two hundred yards distant. Here the limestone showed above the surface, and the specimen was taken from between two large masses of fixed rock, and about a foot distant from each.

11. Black rich soil, from woodland between the Hot and Warm Springs, in Bath County. The specimen was part of what was in contact with a mass of limestone.

12. Soil from the western foot of the Warm Spring Mountain, on a gentle slope between the court house and the road, and about one hundred and fifty yards from the Warm Bath. Rich brown loam, containing many small pieces of limestone, but no finely divided calcareous earth.

13. A specimen taken two or three hundred yards from the last, and also at the foot of the mountain. Soil, a rich black loam, full of small fragments of limestone of different sizes, between that of a nutmeg and small shot. The land had never been broken up for cultivation. One thousand grains contained two hundred and forty grains of small stone or gravel, mostly limestone, separated mechanically, and sixty-nine grains of finely divided calcareous earth.

14. Black loamy clay, from the excellent wheat soil adjoining the town of Bedford in Pennsylvania: the specimen taken from beneath and in contact with limestone. One thousand grains yielded less than one grain of calcareous earth.

15. A specimen from within a few yards of the last, but not in contact with limestone, contained no calcareous earth: neither did the red clay subsoil, six inches below the surface.

16. Very similar soil, but much deeper, adjoining the principal street of Bedford—the specimen taken from eighteen inches below the surface, and adjoining a mass of limestone. A very small disengagement of gas indicated the presence of calcareous earth—but certainly less than one grain in one thousand, and perhaps not half that quantity.

17. Alluvial soil on the Juniata, adjoining Bedford.

18. Alluvial vegetable soil near the stream flowing from all the Saratoga Mineral Springs, and necessarily often covered and soaked by those waters, and

19. Soil taken from the bed of the same stream —neither contained any portion of carbonate of lime.

Thus it appears, that of nineteen specimens of soils, only four contained calcareous earth, and three of these four, in exceedingly small proportions. It should be remarked that all these were selected from situations, which from their proximity to calcareous rock, or exposure to calcareous waters, were supposed most likely to present highly calcareous soils. If five hundred specimens had been taken without choice, from what are commonly limestone soils, (merely because they are not very distant from limestone rock, or springs of limestone water,) the analysis of that whole number would be less likely to show calcareous earth, than the foregoing short list. I therefore feel justified, from my own few examinations, and unsupported by any other authority, to pronounce that calcareous earth will very rarely be found in any soils between the falls of our rivers, and the navigable western waters. In a few specimens of some of the best soils from the borders of the Mississippi and its tributary rivers, I found calcareous earth present in all—but in small proportions, and in no case exceeding two per cent.

The only soils of considerable extent of surface which, from the specimens that I have examined, appear to be highly calcareous, and to agree in that respect, with many European soils, are from

om has already fixed it. But it should not be extended o any soils except those which are so near to limetone rock, as in some measure to be thereby affected n their qualities and value.

the *prairies*, those lands of the west which, whether rich or poor, are remarkable for being destitute of trees, and covered with grass, so as to form natural meadows. The examinations were made but recently, (in 1834) and are reported because presenting striking exceptions to the general constitution of soils in this country.

20. Prairie soil of the most productive kind in Alabama, is a black clay, with very little sand, yet so far from being stiff, that it becomes too light by cultivation. This kind of land is stated by the friend to whom I am indebted for the specimens, to "produce corn and oats most luxuriantly—and also cotton for two or three years; but after that time cotton is subject to the rust, probably from the then open state of the soil, which by cultivation has by that time become as light and as soft as a bank of ashes." One hundred grains of the specimen contained eight of carbonate of lime. All this prairie land in Alabama lies on a substratum of what is there called "rotten limestone," (specimens of which contained seventy-two to eighty-two per cent. of lime,) and which rises to the surface sometimes, forming the "bald prairies," a sample of the soil of which (21) contained fifty-nine per cent. of carbonate of lime. This was described as "comparatively poor—neither trees nor bushes grow there, and only grass and weeds before cultivation—corn does not grow well—small grain better—and cotton soon becomes subject to the rust." The excessive proportion of calcareous earth is evidently the cause of its barrenness.

The substratum called limestone is soft enough to be cut easily and smoothly with a knife, and some of it is in appearance and texture more like the chalk of Europe, than any other earth that I have seen in this country.

22. A specimen of the very rich "cane brake" lands in Marengo County, Alabama, contained sixteen per cent. of carbonate of lime. This is a kind of prairie, of a wetter nature, from the winter rains not being able to run off from the level surface, nor to sink through the tenacious clay soil, and the solid stratum of limestone below.

23. A specimen from the very extensive "Choctaw Prairie" in Mississippi, of celebrated fertility, yielded thirteen per cent. of carbonate of lime.

Several other specimens of different, but all of very fertile soils from Southern Alabama, and all lying over the substratum of soft limestone, were found to be *neutral*, containing not a particle of lime in the form of *carbonate*. These specimens were as follows:—

24. One from the valley cane land—"very wet through the winter, but always dry in summer—and after being ditched, is dry enough to be cultivated in cotton, which will grow from eight to twelve feet high."

25. Another from what is called the best "post-oak land," on which trees of that kind grow to the size of from two to four feet in diameter—having but little underwood, and no cane growth—"thought to be nearly as rich as the best cane land, and will produce 1500 lbs. or more, of seed cotton, or fifty bushels of corn to the acre."

26. Another from what is termed "palmetto land, having on it that plant as well as a heavy cover of large trees growing luxuriantly. It is a cold and wet soil before being brought into good tilth; but afterwards is soft and easy to till, and produces corn and cotton finely. The cane on it is generally small: the soil from four to ten feet deep."*

The foregoing details, respecting limestone lands, may perhaps be considered an unnecessary digression, in a treatise on the soils of the tide-water district. But the analysis of limestone soils furnishes the strongest evidence of the remarkable and novel fact of the general absence of calcareous earth—and the information thence derived, will be used to sustain the following steps of my argument.

All the examinations of soils in this chapter concur in opposing the general application of the proposition that the deficiency of calcareous earth is the cause of the sterility of our soils: and having stated the objection in all its force, I shall now proceed to inquire into its causes, and endeavor to dispel its apparent opposition to my doctrine.

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## CHAPTER VII.

### PROOFS OF THE EXISTENCE OF ACID AND NEUTRAL SOILS.

### Proposition 2. *Continued.*

Sufficient evidence has been adduced to prove that many of our most fertile and valuable soils are destitute of calcareous earth: but it does not necessarily follow that such has always been their composition—or that they may not now contain lime combined with some other acid than the carbonic. That this is really the case, I shall now offer proofs to establish—and not only maintain this position with regard to those valuable soils, but shall contend that lime in some proportion, combined with *vegetable acid*, is present in every soil capable of supporting vegetation.

But while I shall endeavor to maintain these positions, without asking or admitting any exception, let me not be understood as asserting that the original ingredient of calcareous earth was always the sole cause of the fertility of any particular soil, or that a knowledge of the proportion contained, would serve to measure the capacity of the soil for improvement. Calcareous soils not differing materially in qualities or value, often exhibit a remarkable difference in their respective proportions of calcareous earth: so that it would seem, that a small quantity, aided by some other unknown agent, may give as much capacity for improvement, and ultimately produce as much fer

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* It is proper to mention a circumstance which may have had some effect in removing the carbonate of lime from these Alabama soils, besides the more general causes which will be traced in the next chapter. With these specimens of soil, was sent a collection of the small stones and gravel which were stated to be found generally through these soils, and particularly in the clay subsoil beneath. Among these there were several fragments of *sulphuret of iron*. This mineral when decomposing in the earth in contact with carbonate of lime, also decomposes the latter substance, and forms sulphate of lime, [gypsum,] instead. It is well worth inquiry whether sulphuret of iron is generally found in these soils. It may be known by its great weight, and metallic lustre when broken, (which has caused it often to be mistaken for silver ore,) and by giving out fumes of burning sulphur when subjected to strong heat under a blow pipe.

tility, as ten times that proportion, under other circumstances.

In all naturally poor soils, producing freely, in their virgin state, pine and whortleberry, and sorrel after cultivation, I suppose to have been formed some *vegetable acid*, which, after taking up whatever small quantity of lime might have been present, still remains in excess in the soil, and nourishes in the highest degree the plants named above, but is a poison to all useful crops; and effectually prevents such soils becoming rich, from either natural or artificial applications of putrescent manures.

In a *neutral soil*, I suppose calcareous earth to have been sufficiently abundant to produce a high degree of fertility—but that it has been decomposed, and the lime taken up, by the gradual formation of vegetable acid, until the lime and the acid neutralize and balance each other, leaving no considerable excess of either. Such are all our fertile soils that are not calcareous.

These suppositions remain to be proved, in all their parts.

No opinion has been yet advanced that is less supported by good authority, or to which more general opposition may be expected, than that which supposes the existence of acid soils. The term *sour soil* is frequently used by farmers, but in so loose a manner as to deserve no consideration: it has been thus applied to any cold and ungrateful land, without intending that the term should be literally understood, and perhaps without attaching to its use any precise meaning whatever. Dundonald only, of all those who have applied chemistry to agriculture, has asserted the existence of vegetable acid in soils:* but he has offered no analysis, nor any other evidence to establish the fact—and his opinion has received no confirmation, nor even the slightest notice, from later and more able investigators of the chemical characters of soils. Kirwan and Davy profess to enumerate all the common ingredients of soils, and it is not intimated by either, that vegetable acid is one of them. Even this tacit denial by Davy, more strongly opposes the existence of vegetable acid, than it is supported by the opinion of Dundonald, or any of those writers on agriculture who have admitted its existence. Grisenthwaite, a late writer on agricultural chemistry, and who has the advantage of knowing the discoveries, and comparing the opinions of all his predecessors, expressly denies the possibility of any acid existing in soils. His *New Theory of Agriculture* contains the following passage: "Chalk has been recommended as a substance calculated to correct the sourness of land. It would surely have been a wise practice to have previously ascertained this existence of acid, and to have determined its nature, in order that it might be effectually removed. The fact really is, that no soil was ever yet found to contain any notable quantity of acid. The acetic and the carbonic are the only two that are likely to be generated by any spontaneous decomposition of animal or vegetable bodies, and neither of them have any fixity when exposed to the air." Thus, then, my doctrine is derived of even the feeble support it might have had from Dundonald's mere opinion, if that opinion had not been contradicted by later and better authority: and the only support that I can look for, will be in the facts and arguments that I shall be able to adduce.

I am not prepared to question what Grisenthwaite states as a chemical fact, "that no soil was ever yet found to contain any notable quantity of acid." No soil examined by me for this purpose, gave any evidence of the presence of uncombined acid. Still, however, the term acid may be applied with propriety to soils, in which growing vegetables continually receive acid from the decomposition of others, (for which no "fixity" is requisite,) or in which acid is present, not free, but combined with some base, by which it is readily yielded to promote, or retard, the growth of plants in contact with it. It will be sufficient for my purpose to show that certain soils contain some substance, or possess some quality, which promotes almost exclusively the growth of acid plants—that this power is strengthened by adding known vegetable acids to the soil—and is totally removed by the application of calcareous manures, which would necessarily destroy any acid, if it were present. Leaving it to chemists to determine the nature and properties of this substance, I merely contend for its existence and effects: and the cause of these effects, whatever it may be, for the want of a better name, I shall call *acidity*.

The proofs now to be offered in support of the existence of acid and neutral soils, however weak each may be when considered alone, yet when taken in connexion, will together form a body of evidence not easily to be resisted.

1st Proof. Pine and common sorrel have leaves well known to be acid to the taste; and their growth is favored by the soils which I suppose to be acid, to an extent which would be thought remarkable in other plants on the richest soils. Except wild locust on the best river land, no growth can compare in rapidity with pines on soils naturally poor, and even greatly reduced by long cultivation. Pines usually stand so thick on old exhausted fields, that the increase of size in each plant is greatly retarded—but if the whole growth of an acre is estimated, it would probably exceed in quantity the different growth of the richest soils, of the same age and on an equal space. Every cultivator of corn on poor light soil knows how rapidly sorrel* will cover his otherwise naked field, unless kept in check by continual tillage—and that to root it out, so as to prevent the like future labor, cannot be effected by any mode of cultivation whatever. This weed too is considered far more hurtful to growing crops, than any other of equal size. Yet neither of these acid plants can thrive on the best lands. Sorrel cannot even live on a calcareous soil—and if a pine is sometimes found there, it has nothing of its usual elegant form, but seems as stunted and ill shaped as if it had always suffered for want of nourishment. Innumerable facts, of which these are examples, prove that these acid plants must derive from their

*Dundonald's Connexion of Chemistry and Agriculture.

* Sheep sorrel, or *Rumex acetosa*. The wood sorrel (*oxalis acetocella*) is of a very different character. This prefers rich and calcareous soils, and I have seen it growing on places calcareous to excess. It would seem, therefore, that wood sorrel forms its acid from the atmosphere, and does not draw it from the soil, as is evidently the case with common sorrel.

favorite soil some kind of food peculiarly suited to their growth, and quite useless, if not hurtful, to cultivated crops.

2. Dead acid plants are the most effectual in promoting the growth of living ones. When pine leaves are applied to a soil, whatever acid they contain is of course given to that soil, for such time as circumstances permit it to retain its form, or peculiar properties. Such an application is often made on a large scale, by cutting down the second growth of pines, on land once under tillage, and suffering them to lie a year before clearing and cultivating the land. The invariable consequence of this course, is a growth of sorrel for one or two crops, so abundant and so injurious to the crops, as to more than balance any benefit derived by the soil, from the vegetable matter having been allowed to rot. From the general experience of this effect, most persons put pine land under tillage as soon as cut down, after carefully burning the whole of the heavy cover of leaves, both green and dry. Until within a few years, it was generally supposed that the leaves of pine were worthless, if not hurtful, in all applications to cultivated land—which opinion doubtless was founded on such facts as have been just stated. But if they are used as litter for cattle, and heaped to ferment, the injurious quality of pine leaves is destroyed, and they become a valuable manure. This practice is but of recent origin—but is highly approved, and rapidly extending.

On one of the washed and barren declivities (or *galls*) which are so numerous on all our farms, I had the small gullies packed full of green pine bushes, and then covered with the earth drawn from the equally barren intervening ridges, so as nearly to smooth the whole surface. The whole piece had borne nothing previously except a few scattered tufts of poverty grass, and dwarfish sorrel, all of which did not prevent the spot seeming quite bare at midsummer, if viewed at the distance of one hundred yards. This operation was performed in February or March. The land was not cultivated, nor again observed until the second summer afterwards. At that time, the piece remained as bare as formerly, except along the filled gullies, which throughout the whole of their crooked courses, were covered by a thick and tall growth of sorrel, remarkably luxuriant for any situation, and which being bounded exactly by the width of the narrow gullies, had the appearance of some vegetable sown thickly in drills, and kept clean by tillage. So great an effect of this kind has not been produced within my knowledge—though facts of like nature and leading to the same conclusion, are of frequent occurrence. If small pines standing thinly over a broom-grass old field, are cut down and left to lie, under every top will be found a patch of sorrel, before the leaves have all rotted.

3. The growth of sorrel is not only peculiarly favored by the application of vegetables containing acids already formed, but also by such matters as will form acid in the course of their decomposition. Farm-yard manure, and all other putrescent animal and vegetable substances, form *acetic acid* as their decomposition proceeds.* If heaps of rotting manure are left without being spread, in a field the least subject to produce sorrel, a few weeks of growing weather will bring out that plant close around every heap—and for some time, it will continue to show more benefit from that rank manuring than any other grass. For several years my winter-made manure was spread and ploughed in on land not cultivated until the next autumn, or the spring after. This practice was founded on the mistaken opinion, that it would prevent much of the usual exposure to evaporation and waste of the manure. One of the reasons which alone would have compelled me to abandon this absurd practice, was, that a crop of sorrel always followed, (even on good soils that before barely permitted a scanty growth to live,) which so injured the next grain crop as greatly to lessen the benefit from the manure. Sorrel unnaturally produced by such applications, does not infest the land longer than until we may suppose the acid to have been removed by cultivation, and other causes.

It may be objected that my authorities prove only the formation of a single vegetable acid in soil, the acetic—that my facts show only the production of a single acid plant, sorrel—and that the acid which sorrel contains is not the acetic, but the oxalic.* From the application of acids to recently ploughed land, no acid plant except sorrel is made to grow, because that only can spring up speedily enough to arrest the fleeting nutriment. Poverty grass grows only on the same kinds of soil, and generally covers them after they have been a year free from a crop, but does not show sooner—and pines require two years before their seeds will produce plants. But when pines begin to spread over the land, they soon put an end to the growth of all other plants, and are abundantly supplied with their acid food, from the dropping of their own leaves. Thus they may be first supplied with the vegetable acid ready formed in the leaves, and afterwards with the acetic acid, formed by their subsequent slow decomposition. It does not weaken my argument, that the product of a plant is a vegetable acid different from the one supposed to have nourished its growth. All vegetable acids (except the prussic) however different in their properties, are composed of the same three elementary bodies, differing only in their proportions†—and consequently are all convertible into each other. A little more, or a little less of one or the other of these ingredients, may change the acetic to the oxalic acid, and that to any other. We cannot doubt but that such simple changes may be produced by the chemical powers of vegetation, when others are effected, far more difficult for us to comprehend. The most tender and feeble organs, and the mildest juices, aided by the power of animal or vegetable life, are able to produce decompositions and combinations, which the chemist cannot explain, and which he would in vain attempt to imitate.

4. This ingredient of soils which nourishes acid plants, also poisons cultivated crops. Plants have not the power of rejecting noxious fluids, but take up by their roots every thing presented in a soluble form.‡ Thus the acid also enters the sap-vessels of cultivated plants, stunts their growth, and make

* Agr. Chem. p. 187.

* Agr. Chem. Lecture 3.

† Carbon, Oxygen and Hydrogen. Agr. Chem. Lecture 3, p. 78.

‡ Agr. Chem. Lecture 6, page 186.

t impossible for them to attain that size and per-
ection, which their proper food would ensure, if it was presented to them without its poisonous accompaniment. When the poorest virgin woodland is cut down, it is covered and filled to excess with leaves and other rotted and rotting vegetable matters. Can a heavier vegetable manuring be desired? And as it completely rots during cultivation, must not it offer to the growing plants as abundant a supply of food as they can require?—Yet the best product obtained may be from ten to fifteen bushels of corn, or five or six of wheat, soon to come down to half those quantities. If the noxious quality which causes such injury is an acid, it is as certain as any chemical truth whatever, that it will be neutralized, and its powers destroyed, by applying enough of calcareous earth to the soil: and precisely such effects are found whenever that remedy is tried. On land thus relieved of this unceasing annoyance, the young corn no longer appears of a pale and sickly green, approaching to yellow, but takes immediately a deep healthy color, by which it may readily be distinguished from any on soil left in its former state, before there is any perceptible difference in the size of the plants. The crop will produce fifty to one hundred per cent. more, the first year, before its supply of food can possibly have been increased—and the soil is soon found not only cleared of sorrel, but incapable of producing it. I have anticipated these effects of calcareous manures, before furnishing the proof—but they will hereafter be established beyond contradiction.

The truth of the existence of either acid, or neutral soils, depends on the existence of the other—and to prove either, will necessarily establish both. If acid exists in soils, then wherever it meets with calcareous earth, the two substances must combine and neutralize each other, so far as their proportions are properly adjusted. On the other hand, if I can show that compounds of lime and vegetable acid are present in most soils, it follows inevitably that nature has provided means by which soils can generally obtain this acid: and if the amount formed can balance the lime, the operation of the same causes can exceed that quantity, and leave an excess of free acid. From these premises will be deduced the following proofs.

5. It has been stated (page 18) that the process recommended by chemists for finding the calcareous earth in soils was unfit for that purpose, because a *precipitate* was always obtained even when no calcareous earth, or carbonate of lime was present. Frequent trials have shown me that this precipitate is considerably more abundant from good soils than bad. The substance thus obtained from rich soils by solution and precipitation, in every case that I have tried, contains some calcareous earth, although the soil from which it was derived had none. The alkaline liquor from which the precipitate has been separated, we are told by Davy will, after boiling, let fall the carbonate of magnesia, if any had been in the soil: but when any notable deposite is thus obtained, it will often be found to consist more of carbonate of lime, than of magnesia. The following are examples of such products:

One thousand grains of tide marsh soil (described page 20) acted on by muriatic acid in the pneumatic apparatus, gave out no carbonic acid gas, and therefore could have contained no carbonate of lime. The precipitate obtained from the same weighed sixteen grains—which being again acted on by sulphuric acid, evolved as much gas as showed that three grains had become carbonate of lime, in the previous part of the process.

Two hundred grains of alluvial soil from Saratoga Springs (page 21, No. 18,) containing no carbonate of lime, yielded a precipitate of twelve grains, of which three was carbonate of lime—and a deposite from the alkaline solution weighing six grains, four of which was carbonate of lime.

Seven hundred grains of limestone soil from Bedford (part of the specimen marked 14, page 21,) contained about two-thirds of a grain of carbonate of lime—and its precipitate of twenty-eight grains, only yielded two grains: but the alkaline solution deposited eleven grains of the carbonates of lime and magnesia, of which at least five was of the former, as there remained seven and a half of solid matter, after the action of sulphuric acid.*

From this process, there can be no doubt but that the soil contained a proportion of some *salt of lime* (or lime combined with some kind of acid) which being decomposed by and combined with the muriatic acid, was then precipitated, not in its first form, but in that of carbonate of lime—it being supplied with carbonic acid from the carbonate of potash, used to produce the precipitation. The proportions obtained in these cases were small; but it does not follow that the whole quantity of lime contained in the soil was found. However, to the extent of this small proportion of lime is proved clearly the presence of enough of some acid (and that not the carbonic) to combine with it. Neither could it have been the sulphuric, or the phosphoric acid: for though both the sulphate and phosphate of lime are in some soils, yet neither of these salts can be decomposed by muriatic acid.

6. The strongest objection to the doctrine of neutral soils is, that if true, the salt formed by the combination of the lime and acid must often be present in such large proportions, that it is scarcely credible that its presence and nature should not have been discovered by any of the chemists who have analyzed soils. This difficulty I cannot remove: but it may be met (or neutralized—to borrow a figure from my subject,) by showing that an equal difficulty awaits those who may support the other side of the argument.

* The measurement of the carbonic acid gas evolved, was relied on to show the whole amount of *carbonates* present—and sulphuric acid was used to distinguish between lime and magnesia, in the deposite from the alkaline solution. If any alumine or magnesia had made part of the solid matter exposed to diluted sulphuric acid, the combinations formed would have been soluble salts, which would of course have remained dissolved and invisible in the fluid. Lime only of the four earths forms with sulphuric acid a substance but slightly soluble, and which therefore can be mostly separated in a solid form. The whole of this substance (sulphate of lime) cannot be obtained in this manner, as a part is always dissolved: but whatever is obtained, proves that at least two-thirds of that quantity of carbonate of lime had been present: as that quantity of lime which will combine with enough carbonic acid to make 100 parts (by weight) of carbonate of lime, will combine with so much more of sulphuric acid, as to form about 159 parts of the sulphate of lime, or gypsum.

The theory of geologists of the formation of soils from the decomposition, or disintegration of rocks, is received as true by scientific agriculturists. The soils thus supposed to be formed, receive admixtures from each other, by means of different operations of nature, and after being more or less enriched by the decay of their own vegetable products, make the endless variety of existing soils.* But where a soil lying on, and thus supposed to have been formed from any particular kind of rock, is so situated that it could not have been moved, or received considerable accessions from torrents, or other causes, then, according to this theory, the rock and the soil should be composed of the same materials—and such soils as the specimens marked 11 and 16 (page 21) would be, like the rock they touched, nearly pure calcareous earth, instead of being (as they were in truth) destitute, or nearly so, of that ingredient. Such are the doctrines received and taught by Davy, or the unavoidable deductions from them. But without contending for the full extent of this theory of the formation of soils, (because I consider it almost entirely false,) every one must admit that soils thus situated, must have received in the lapse of ages, some accessions to their bulk, from the effects of frost, rain, sun, and air, on the limestone in contact with them. All limestone soils, properly so called, exhibit certain marked and peculiar characters of color, texture, and products, which can only be derived from receiving into their composition more or less of the rock which lies beneath, or rises above their surface. This mixture will not be denied by any one who has observed limestone soils, and reasons fairly, whether his investigation begins with the causes, or their effects. If then all this gain of calcareous earth remains in the soil, why is none, or almost none, discovered by accurate chemical analysis? Or, if it be supposed not present, nor yet changed in its chemical character, in what possible manner could a ponderous and insoluble earth have made its escape from the soil? To remove this obstacle without admitting the operation of acid in making such soils neutral, will be attended with at least as much difficulty, as any arising from that admission being made.

7. But we are not left entirely to conjecture that soils were once more calcareous than they now are, if chemical tests can be relied on to furnish proof. Acid soils that have received large quantities of calcareous earth as manure, after some time, will yield very little when analyzed. To a soil of this kind, full of vegetable matter, I applied, in 1818 and 1831, fossil shells at such a known and heavy rate as would have given to the soil (by calculation) at least three per cent. of calcareous earth, for the depth of five inches. Only a small portion of the shelly matter was very finely divided when applied. Since the application of the greater part of this dressing, (only one-fourth having been laid on in 1818,) no more than six years had passed before the following examinations were made—and the cultivation of five crops in that time, three of which were horse-hoed, must have well mixed the calcareous earth with the soil. Three careful examinations gave the following results.

| | | |
|---|---|---|
| No. 1.—1000 grains yielded | $7\frac{1}{2}$ | of coarse calcareous earth, (fragments of shells.) |
| And less than | $\frac{1}{2}$ | of finely divided. |
| | 8 | |
| No. 2.—1000 grains yielded | 5 | of coarse, |
| | 2 | finely divided. |
| | 7 | |
| No. 3.—1500 grains yielded | 15 | of coarse, |
| | $2\frac{1}{2}$ | finely divided. |
| | $17\frac{1}{2}$ | |

The specimens No. 1 and No. 2 were obtained by taking handfuls of soil from several places, (four in one case, and twelve in the other) mixing them well together, and then taking the samples for trial from the two parcels. On such land, when not recently ploughed, there will always be an over-proportion of the pieces of shells on the surface, as the rains have settled the fine soil, and left exposed the coarse matters. On this account, in making these two selections, the upper half inch was first thrown aside, and the handful dug from below. No. 3 was taken from a spot showing a full average thickness of shells, and included the surface. I considered the three trials made as fairly as possible, to give a general average. Small as is the proportion of finely divided calcareous earth exhibited, it must have been increased by rubbing some particles from the coarse fragments, in the operation of separating them by a fine sieve. Indeed it may be doubted whether any proportion remained very finely divided—or in other words, whether it was not combined with acid, as fast as it was so reduced. But without the benefit of this supposition, the finely divided calcareous earth in the three specimens, averaged only one and one-fourth grains to the thousand, which is one twenty-fourth of the quantity laid on: and the total quantity obtained, of coarse and fine, is eight grains in one thousand, or about one-fourth of the original proportion. All the balance had changed its form, or otherwise disappeared, in the few years that had passed since the application.

The very small proportions of finely divided calcareous earth compared to the coarse, in some shelly soils, furnish still stronger evidence of this kind. Of the York River soil, (described page 19, No. 5,)

| | |
|---|---|
| 1260 grains, yielded of coarse calcareous parts, - - - | 168 grains |
| And of finely divided, - | 8 |
| 1044 of the rich Nansemond soil, (No. 6,) - - - | 544 coarse |
| | 18 fine. |

As many of the shells and their fragments in these soils are in a mouldering state, it is incredible that the whole quantity of finely divided particles derived from them should have amounted to no more than these small proportions. Independent of the action of natural causes, the plough

* Agr. Chem. p. 131. Also Treatise on Agriculture (by General Armstrong) in vol. I. of American Farmer, quoted in Appendix D.

lone, in a few years, must have pulverized at east as much of the shells, as was found.

8. In other cases, where the operations of nature ave been applying calcareous earth, for ages, one now remains in the soil; and the proof thence erived is more striking, than any obtained from rtificial applications, of only a few years standing. Valleys subject to be frequently overflown and aturated by the water of limestone streams, must ecessarily retain a new supply of calcareous earth rom every such soaking and drying.

Limestone water contains the *super-carbonate of ime*, which is soluble: but this loses its excess of arbonic acid when left dry by evaporation, and ecomes the carbonate of lime, which not being oluble, is in no danger of being removed by subequent floods. Thus accessions are slowly but ontinually made, through many centuries. Yet uch soils are found containing no calcareous earth —of which a remarkable example is presented in the soil of the cultivated part of the Sweet Spring Valley, (No. 8, page 21.)*

9. All *wood ashes* contain salts of lime, (and most kinds in large proportions,) which could have been derived from no other source than the soil on which the trees grew. The lime thus obtained is principally combined with carbonic acid, and partly with the phosphoric, forming phosphate of lime. The table of Saussure's analyses of the ashes of numerous plants,† is sufficient to show that these products are general, if not universal. The following examples of some of my own examinations, prove that ashes yield calcareous earth in proportions suitable to their kind, although the wood grew on soils destitute of that ingredient—as was ascertained with regard to each of these soils.

| 100 *grains of ashes from.* | *What soil taken from.* | Carbonate of Lime. | Phosphate of Lime. |
|---|---|---|---|
| Whortleberry bushes, the entire plants, except the leaves, | Acid silicious loam, | 4 grains. | 4 grains. |
| Equal parts of the bark, heart, and sapwood, of an old locust, | The same, | 51 | 18 |
| Young locust bushes entire, | Rich neutral clay loam, | 40 | 30 |
| Young pine bushes, | Acid silicious loam, | 9 | 6 |
| Body of a young pine tree. | Acid clay soil. | 14 | 18 |

The potash was first carefully taken out of all hese samples. The remaining solid matter was ilicious sand, and charcoal: the proportion of the atter varying according to the degree of heat used n burning the wood, which was not permitted to e very strong, for fear of converting the calcareous earth into quick-lime.

All the carbonate of lime yielded by ashes, was ecessarily furnished in some form by the soil on which the plants grew—and when the soil itself ontained no carbonate, some other compound of ime must have been present, to enable us to acount for these certain and invariable results. The resence of a combination of lime with some *vegetable* acid, and none other, would serve to proluce such effects. According to established chemcal laws, if any such combination had been taken p into the sap-vessels of the tree, it would be deomposed by the heat necessary to convert the wood to ashes; the acid would be reduced to its lementary principles, and the lime would immeliately unite with the carbonic acid, (which is roduced abundantly by the process of combusion,) and thus present a product of *carbonate of ime* newly formed from the materials of the other ubstances decomposed.‡

On the foregoing facts and deductions, I am ontent to rest the truth of the existence of acid nd neutral soils.

I have chosen to leave all the preceding part of this chapter (with the exception of a few merely verbal corrections and alterations) precisely as it appeared in the first edition of this essay, (January 1832.) But since that time I have first heard of a discovery, and of consequent investigations by men of science, which seem to furnish direct proof of what I have been contending for, viz: *the existence of a vegetable acid substance in soils and manures, generally diffused, and often in large proportions, and yet which had not been known or suspected by chemists previously.* The first intimation of this discovery which reached me was in the *Alphabet of Scientific Gardening*, by Professor Rennie, published in London in 1833, from which the part relative to this subject will be quoted below. Since then I have been enabled to consult the late French work of Berzelius, in which his views of humic acid are given more at length, and from which an extract will be translated and given in the appendix. [See F.] The facts respecting humic acid, as concisely stated in the follow-

‡ The reasoning on the presence of the carbonate of ime found in ashes from acid soils, does not apply to he phosphate of lime which is always also present. The atter salt is not decomposed by any known degree of eat, [Art. *Chemistry, in Edin. Ency.*] and therefore night have remained unchanged, in passing from the oil to the tree, and thence to the ashes.

* The excess of carbonic acid which unites with lime and renders the compound soluble in water, is lost by exposure of the calcareous water to the air, as well as by evaporation to dryness. [Accum's Chemistry—Lime.] The masses of soft calcareous rock which are deposited in the rapids of limestone streams, are examples of the loss of carbonic acid from exposure to the air; and the stalactites in caves, the deposite of the slow-dropping water holding in solution the super carbonate of lime, are examples of the same effect produced by evaporation. A similar deposite of insoluble carbonate of lime, from both these causes, is necessarily made on all land subject to be overflowed by limestone waters.

† Quoted in Agr. Chem. Lecture 3.

ing quotation from Professor Rennie, furnish strong confirmation of some of the opinions which I have endeavored to maintain. It will however be left, without farther comment, for the reader to observe the accordance, and to make the application.

"HUMIC ACID AND HUMIN.—In most chemical books the terms *Ulmic Acid* and *Ulmin* are used, from *Ulmus*, elm; but, as its substance occurs in most, if not all plants, the name is bad. I prefer Sprengel's terms, from *Humus*, soil.

This important substance was first discovered by Klaproth, in a sort of gum from an elm; but it has since been found by Berzelius in all barks; by M. Braconnot in saw-dust, starch, and sugar; and what is still more interesting for our present purpose, it has been found by Sprengel and M. Polydore Boullay, to constitute a leading principle in soils and manures. *Humin* appears to be formed of carbon and hydrogen, and the *humic acid* of humin and oxygen. Pure humin is of a deep blackish brown, without taste or smell, and water dissolves it with great difficulty and in small quantities; consequently it cannot, when pure, be available as food for plants.

Humic acid however, which I may remark, *is not sour to the taste*, readily combines with many of the substances found in soils and manures, and not only renders them, but itself also, easy to be dissolved in water, which in their separate state could not take place. In this way *humic acid will combine with lime, potass, and ammonia, in the form of humates, and the smallest portion of these will render it soluble in water and fit to be taken up by the spongelets of the root fibres.*

It appears to have been from ignorance of the important action of the humic acid in thus helping to dissolve earthy matters, that the older writers were so puzzled to discover how lime and potass got into plants; and it seems also to be this, chiefly, which is so vaguely treated of in the older books, under the names of *extractive, vegetable extract, mucilaginous matter*, and the like. Saussure, for instance, filled a vessel with turf, and moistened it thoroughly with pure water, when by putting ten thousand parts of it by weight under a heavy press, and filtering and evaporating the fluid, he obtained twenty-six parts of what he termed *extract;* from ten thousand parts of well dunged and rich kitchen garden mould, he obtained ten parts of *extract;* and from ten thousand parts of good corn field mould, he obtained four parts of *extract.*

M. Polydore Boullay found that the liquid manure, drained from dung hills, contains a large proportion of humic acid, which accounts for its fertilizing properties so well known in China and on the continent: and he found it also in peat earth, and in varying proportions in all sorts of turf. It appears probable, from Gay-Lussac having found a similar acid, (technically *Azumic acid,*) on decomposing the prussic acid, (technically *Hydrocyanic acid,*) that the humic acid may be found in animal blood, and if so, it will account for its utility as a manure for vines, &c. Dobereiner found the gallic acid convertible into the humic."

But without the aid of this recent discovery of the humic acid, if the foregoing examinations of soils, and the arguments which follow remain unquestioned, these two remarkable and important facts may be considered as established:

1st. That calcareous earth, or carbonate of lime, is in general as entirely deficient in the soils of Virginia, as that ingredient has heretofore been supposed by agricultural writers, to be common in all soils: and

2nd. That notwithstanding this total absence of the carbonate of lime, that lime in some other form of combination, in greater or less quantities, is an ingredient of every soil capable of producing vegetation.

Nor do these facts come in conflict with each other; nor either of them with the position which has been contended for, that calcareous matter in proper proportions is necessary to cause fertility in soils. Should some other person, who may be aided by sufficient scientific light, undertake the investigation, he may supply all that is wanting for the full proof of this theory of the cause of fertility, by showing that the value of a soil (under equal circumstances) is in proportion to the quantity of the vegetable salt of lime present in the soil. The direct and positive proof of this doctrine, I confidently anticipate will hereafter be obtained from more full examinations of the humic acid, and its compounds in various soils, and from correct and minute reports of the quantities and kinds of those ingredients, and of the rate of natural fertility of each soil. As yet, however interesting the recent discovery of humic acid may be to chemists, it does not seem that they have suspected it to have any thing like the important bearing on the fertilization of soil, which I had attributed to the supposed acid principle or ingredient.

Supposing the doctrine to be sufficiently proved, it may be useful to trace the formation of acidity in different soils, according to the views which have been presented, and to display the promise which that quality holds out for improving those soils, which it has hitherto rendered barren and worthless.

Every neutral soil at some former time contained calcareous earth in sufficient quantity to produce the uniform effect of that ingredient of storing up and fixing fertility. The decomposition of the successive growth of plants left to rot on the rich soil, continually formed vegetable acid, which slowly and gradually united with the lime in the soil. At last these two principles balanced each other, and the soil was no longer calcareous, but became neutral. Instead of its former ingredient carbonate of lime, it was now supplied with a *vegetable salt of lime.* This change of soil does not effect the natural growth, which remains the same, and thrives as well as when the soil was calcareous—and when brought into cultivation, the soil is equally productive under all crops suited to calcareous soils. If the supplies of vegetable matter continue, the soil may even become acid in some measure, as may be evidenced by the growth of sorrel—but without losing any of its fertility before acquired. The quantity of acidity in any soil frequently varies: it is increased by the growth of such plants as delight to feed on it, and by the decomposition of all vegetable matters. Hence the longer a poor field remains at rest, and not grazed, the more acid it becomes—and this evil keeping pace with the benefits derived, is the cause why so little improvement, or increased product, is obtained from putting acid soils under that mild treatment. Cultivation not only prevents new supplies, but also diminishes the acidity al-

eady present in excess, by exposing it to the atnosphere—and the more a soil is exhausted, the nore will its acidity be lessened.

We have seen from the proof furnished by the nalysis of wood ashes, that even poor acid soils contain a little salt of lime, and therefore must nave been slightly calcareous at some former time. But such small proportions of calcareous earth were soon equalled, and then exceeded, by the formation of vegetable acid, before much productiveness was caused. The soil being thus changed, the plants suitable to calcareous soils died off, and gave place o others which produce, as well as feed and thrive on acidity. Still, however, even these plants furnish abundant supplies of vegetable matter, sufficient to enrich the land in the highest degree: but he antiseptic power of the acid prevents the leaves rom rotting for years, and even then, the soil has no power to profit by them. Though continually vasted, the vegetable matter is always present in abundance; but must remain almost useless to the soil, until the accompanying acidity shall be destroyed.

It may well be doubted whether any soil destitute of lime in every form, would not soon become a perfect barren, incapable of producing a spire of grass. No soil thus destitute is known, as the plants of all soils show in their ashes the presence of some lime. But it is probable that our subsoils, which when left naked by the washing away of he soil, are so generally and totally barren, are made so by their being entirely destitute of lime n any form. There is a natural process regularly and at all times working to deprive the subsoil of ll lime, unless the soil is abundantly supplied. What constitutes soil, and makes the strong and plain mark of separation and distinction between he more or less fertile soil and the absolutely steril subsoil beneath? The most obvious cause for this difference which might be stated, is the dropping of the dead vegetable matter on the surface: but this is not sufficient alone to produce the effects, though it may be when aided by another cause of more power. When the most barren soil was formed or deposited by any of the natural agents to which such effects are attributed by geologists, it seems reasonable to suppose that he surface was no richer than any lower part. If then a very minute proportion of lime had been equally distributed through the body of poor soil to any depth that the roots of trees could penetrate, it would follow that the roots would in the course of time take up all the lime, as all would be wanting for the support of the trees: and their death and decay would afterwards leave all this former ingredient of the soil in general, on the surface. This process must have the effect, in the course of time, of fixing on and near the surface the whole of a scanty supply of lime, and on leaving the subsoil without any. But if there is within the reach of the roots more lime than any one crop or growth of plants need, then the superfluous lime will be permitted to remain in the subsoil, which will then be improvable by vegetable substances, and readily convertible to productive soil. The manner in which lime thus operates, will be explained in the next chapter.

Nearly all the woodland now remaining in Lower Virginia, and much of what has long been arable, is rendered unproductive by acidity, and successive generations have toiled on them without remuneration, and without suspecting that their worst virgin land was then richer than their manured lots appeared to be. The cultivator of such soil, who knows not its peculiar disease, has no other prospect than a gradual decrease of his always scanty crops. But if the evil is once understood, and the means of its removal within his reach, he has reason to rejoice that his soil was so constituted as to be preserved from the effects of the improvidence of his forefathers, who would have worn out any land not almost indestructible. The presence of acid, by restraining the productive powers of the soil, has in a great measure saved it from exhaustion; and after a course of cropping which would have utterly ruined soils much better constituted, the powers of our acid land remain not greatly impaired, though dormant, and ready to be called into action by merely being relieved of its acid quality. A few crops will reduce a new acid field to so low a rate of product, that it scarcely will pay for its cultivation—but no great change is afterwards caused, by continuing scourging tillage and grazing, for fifty years longer. Thus our acid soils have two remarkable and opposite qualities, both proceeding from the same cause: they cannot be enriched by manure, nor impoverished by cultivation, to any great extent. Qualities so remarkable deserve all our powers of investigation: yet their very frequency seems to have caused them to be overlooked—and our writers on agriculture have continued to urge those who seek improvement to apply precepts drawn from English authors, to soils which are totally different from all those for which their instructions were intended.

## CHAPTER VIII.

### THE MODE OF OPERATION OF CALCAREOUS EARTH IN SOILS.

Proposition 3. *The fertilizing effects of calcareous earth are chiefly produced by its power of neutralizing acids, and of combining putrescent manures with soils, between which there would otherwise be but little, if any, chemical attraction.*

Proposition 4. *Poor and acid soils cannot be improved durably, or profitably, by putrescent manures, without previously making them calcareous, and thereby correcting the defect in their constitution.*

It has already been made evident that the presence of calcareous earth in a natural soil causes great and durable fertility: but it still remains to be determined, to what properties of this earth its peculiar fertilizing effects are to be attributed.

Chemistry has taught that silicious earth, in any state of division, attracts but slightly, if at all, any of the parts of putrescent animal and vegetable matters.* But even if any slight attraction really exists when the earth is minutely divided for experiment in the laboratory of the chemist, it cannot be exerted by silicious sand in the usual form in which nature gives it to soils—that is, in particles comparatively coarse, loose, and open, and yet each particle impenetrable to any liquid, or gaseous fluid that might be passing through the va-

* Agr. Chem. page 129.

cancies. Hence, silicious earth can have no power, chemical or mechanical, either to attract enriching manures, or to preserve them when actually placed in contact: and soils in which the qualities of this earth greatly predominate, must give out freely all they have received, not only to a growing crop, but to the sun, air, and water, so as soon to lose the whole. No portion of putrescent matter can remain longer than the completion of its decomposition—and if not arrested during this process, by the roots of living plants, all will escape in the form of *gas*, into the air, without leaving a trace of lasting improvement. With a knowledge of these properties, we need not r-sort to the common opinion that manure sinks through sandy soils, to account for its rapid disappearance.*

Aluminous earth, by its closeness, mechanically excludes those agents of decomposition, heat, air and moisture, which sand so freely admits; and therefore clay soils, in which this earth predominates, give out manure much more slowly than sand, whether for waste or for use. The practical effect of this is universally understood—that clay soils retain manure much longer than sand, but require much heavier applications to show as much effect at once. But as this means of retaining manure is altogether mechanical, it serves only to delay both its use and its waste. Aluminous earth also exerts some chemical power in attracting and combining with manures, but too weakly to enable a clay soil to become rich by natural means. For though clays are able to exert more force than sand, in holding manures, their closeness also acts to deny admittance beneath the surface to the enriching matters furnished by the growth and decay of plants: and therefore, before being brought into cultivation, a poor clay soil would derive scarcely any benefit from its small power of combining chemically with putrescent matters. If then it is considered how small is the power of silicious and aluminous earths to receive and retain putrescent manures, it will cease to cause surprise that such soils cannot be thus enriched, with profit, if at all.

Davy states that both aluminous and calcareous earth will combine with any vegetable extract, so as to render it less soluble, and consequently not subject to the waste that would otherwise take place, and hence "that the soils which contain most alumina and carbonate of lime, are those which act with the greatest chemical energy in preserving manures." Here is high authority for calcareous earth possessing the power which my subject requires, but not in so great a degree as I think it deserves. Davy apparently places both earths in this respect on the same footing, and allows to aluminous soils retentive powers equal to the calcareous. But though he gives evidence (from chemical experiments) of this power in both earths, he does not seem to have investigated the difference of their forces. Nor could he deem it very important, holding the opinion which he elsewhere expresses, that calcareous earth acts "merely by forming a useful earthy ingredient in the soil," and consequently attributing to it no remarkable chemical effects as a manure. I shall offer some reasons for believing that the powers of attracting and retaining manure, possessed by these two earths, differ greatly in force.

Our aluminous and calcareous soils, through the whole of their virgin state, have had equal means of receiving vegetable matter; and if their powers for retaining it were nearly equal, so would be their acquired fertility. Instead of this, while the calcareous soils have been raised to the highest condition, many of the tracts of clay soil remain the poorest and most worthless. It is true that one labored under acidity, from which the other was free. But if we suppose nine-tenths of the vegetable matter to have been rendered useless by that poisonous quality, the remaining tenth, applied for so long a time, would have made fertile, any soil that had the power to retain the enriching matter.

Many kinds of shells are partly composed of gelatinous animal matter, which I suppose, must be chemically combined with the calcareous earth, and by that means only is preserved from the putrefaction and waste that would otherwise certainly and speedily take place. Indeed, the large proportion of animal matter which thus helps to constitute shells, instead of making them more perishable, serves to increase their firmness and solidity. When long exposure, as in fossil shells, has destroyed all animal matter, the texture of the calcareous substance is greatly weakened. A simple experiment will serve to separate and make manifest to the eye, the animal matter, which is thus combined with and preserved by the calcareous

* Except the very small proportions of earthy, saline and metallic matters that may be in animal and vegetable manures, the whole balance of their bulk (and the whole of whatever can feed plants,) is composed of different elements, which are known only in the forms of *gases*—into which they must be finally resolved, after going through all the various stages of fermentation and decomposition. So far from sinking in the earth, these final results could not be possibly confined there, but must escape into the atmosphere as soon as they take a gaseous form, unless immediately taken up by the organs of growing plants. It is probable that but a small portion of any dressing of manure remains long enough in the soil to make this final change—and that nearly all is used by growing plants, during previous changes, or carried off by air and water. During the progress of the many changes caused by fermentation and decomposition, every soluble product may certainly sink as low as the rains penetrate: but it cannot descend lower than the water, and that, together with the soluble manure, will be again drawn up by the roots of plants. One exception, however, seems probable. Should the soil need draining, to take off water passing beneath the surface, the soluble manure might be carried off by those springs; and this supposed result receives strong confirmation from the complete loss of fertility which is often observed in spots over a foundation that is springy in wet seasons, but which have been kept under tillage, without being drained. We are as yet but little informed as to the particular changes made, and the various new substances successively formed, and then decomposed, during the whole duration of putrescent manures in the soil—and no field for discovery would better reward the investigations of the agricultural chemist. For want of this knowledge we proceed at random in using manures, instead of being enabled to conform to any rule founded on scientific principles: nor can we hope so to manage manures with regard to their fermentation, the time and manner of application, mixing with other substances, &c., as to *enable the crops to seize every enriching result as soon as it is produced*, and to *postpone as long as possible the final results of decomposition*—which ought to be the ends sought in every application of putrescent manure.

earth. If a fresh water muscle shell is kept for some days immersed in a weak mixture of muriatic acid and water, all the calcareous part will be gradually dissolved, leaving the animal matter so entire, as to appear still to be a whole shell—but which when lifted from the fluid which supports it, will prove to be entirely a flaccid, gelatinous, and putrescent substance, without a particle of calcareous matter being left. Yet this substance which is so highly putrescent when alone, would have been preserved in combination with calcareous matter, in the shell, for many years, if exposed to the usual changes of air and moisture—and if secured from such changes, would be almost imperishable.

Calcareous earth has power to preserve those animal matters which are most liable to waste, and which give to the sense of smell full evidence when they are escaping. Of this, a striking example is furnished by an experiment which was made with care and attention. The carcass of a cow that was killed by accident in May, was laid on the surface of the earth, and covered with about seventy bushels of finely divided fossil shells and earth, (mostly silicious,) their propositions being as thirty-six of calcareous, to sixty-four of silicious earth. After the rains had settled the heap, it was only six inches thick over the highest part of the carcass. The process of putrefaction was so slow, that several weeks passed before it was over; nor was it ever so violent as to throw off any effluvia that the calcareous earth did not intercept in its escape, so that no offensive smell was ever perceived. In October, the whole heap was carried out and applied to one-sixth of an acre of wheat—and the effect produced far exceeded that of the calcareous manure alone, which was applied at the same rate on the surrounding land. No such power as this experiment indicated (and which I have repeated in various modes, and always with like results,) will be expected from clay.

Quicklime is used to prevent the escape of offensive effluvia from animal matter; but its operation is entirely different from that of calcareous earth. The former effects its object by "eating" or decomposing the animal substance, (and nearly destroying it as manure,) before putrefaction begins. The operation of calcareous earth is to moderate and retard, but not to prevent putrefaction—not to destroy the animal matter, but to preserve it effectually, by forming new combinations with the products of putrefaction. This important operation will be treated of more fully in a subsequent chapter.

The power of calcareous earth to combine with and retain putrescent manure, implies the power of fixing them in any soil to which both are applied. The same power will be equally exerted if the putrescent manure is applied to a soil which had previously been made calcareous, whether by nature, or by art. When a chemical combination is formed between the two kinds of manure, the one is necessarily as much fixed in the soil as the other. Neither air, sun or rain, can then waste the putrescent manure, because neither can take it from the calcareous earth, with which it is chemically combined. Nothing can effect the separation of the parts of this compound manure, except the attractive power of growing plants—which as all experience shows, will draw their food from this combination as fast as they require it, and as easily as from sand. The means then by which calcareous earth acts as an improving manure, are, *completely preserving putrescent manures from waste, and yielding them freely for use.* These particular benefits, however great they may be, cannot be seen very quickly after a soil is made calcareous, but will increase with time, and with the means for obtaining vegetable matters, until their accumulation is equal to the soil's power of retention. The kind, or the source, of enriching manure, does not alter the process described. The natural growth of the soil, left to die and rot, or other putrescent manures collected and applied, would alike be seized by the calcareous earth, and fixed in the soil.

This, the most important and valuable operation of calcareous earth, gives nothing to the soil—but only secures the other manures, and gives *them* wholly to the soil. In this respect, the action of calcareous earth on soils, is precisely like that of *mordants* in "setting" or fixing colors. When alum, for example, is used by the dyer for this purpose, it adds not the slightest tinge of itself—but it holds to the cloth, and also to the otherwise fleeting dye, and thus fixes them permanently together. Without the mordant, the color might have been equally vivid, but would be lost by the first wetting of the cloth.

The next most valuable property of calcareous manures for the improvement of soil, is their *power of neutralizing acids*, which has already been incidentally brought forward in the preceding chapter. According to the views already presented, our poorest cultivated soils contain more vegetable matter than they can beneficially use—and when first cleared, have it in great excess. So antiseptic is the acid quality of poor woodland, that before the crop of leaves of one year can entirely rot, two or three others will have fallen—and there are always enough, at any one time, to greatly enrich the soil, if the leaves could be rotted and fixed in it, at once.* The presence of acid, by preventing or retarding putrefaction, keeps the vegetable matter inert, and even hurtful on cultivated land; and the crops are still further injured, by taking up the poisonous acid, with their nutriment. A sufficient quantity of calcareous earth mixed with such a soil, will immediately neutralize the acid, and destroy its powers: the soil, released from its baneful influence, will be rendered capable, for the first time, of exerting the fertility which it really

*The antiseptic effect of vegetable acid in our soils receives some support from the facts established with regard to *peat soils,* in which vegetable acids have been discovered by chemical analysis: and though the peat or moss soils of Britain differ entirely from any soils in this country, still some facts relating to the former class, may throw light on the properties of our own soils, different as they may be. Not only does vegetable matter remain without putrefaction in peat soils and bogs, and serve to increase their depth by regular accessions from the successive annual growths, but even the bodies of beasts and men have been found unchanged under peat, many years after they had been covered. [Aiton's Essay on Moss Earth.] It is well known that the leaves of trees rot very quickly on the rich limestone soils of the western states, while the successive crops of several years' growth may be always found on our acid woodland, in the different stages of their slow decomposition.

possessed. The benefit thus produced is almost immediate: but though the soil will show a new vigor in its earliest vegetation, and may even double its first crop, yet no part of that increased product is due to the direct operation of the calcareous manure, but merely to the removal of acidity. The calcareous earth, in such a case, has not made the soil richer in the slightest degree, but has merely permitted it to bring into use the fertility it had before, and which was concealed by the acid character of the soil. It will be a dangerous error for the farmer to suppose that calcareous earth can enrich soil by direct means. It destroys the worst foe of productiveness, and uses to the greatest advantage the fertilizing powers of other manures—but of itself it gives no fertility to soils, nor furnishes the least food to growing plants.

These two kinds of action are by far the most powerful of the means possessed by calcareous earth, for fertilizing soils. It has another however of great importance—or rather two others, which may be best described together as the *power of altering the texture and absorbency* of soils.

At first it may seem impossible that the same manure could produce such opposite effects on soils, as to lessen the faults of being either too sandy, or too clayey—and the evils occasioned by both the want, and the excess of moisture. Contradictory as this may appear, it is strictly true as to calcareous earth. In common with clay, calcareous earth possesses the power of making sandy soils more close and firm—and in common with sand, the power of making clay soils lighter. When sand and clay thus alter the textures of soils, their operation is altogether mechanical; but calcareous earth must have some chemical action also, in producing such effects, as its power is far greater than that of either sand or clay. A very great quantity of clay would be required to stiffen a sandy soil perceptibly, and still more sand would be necessary to make a clay soil much lighter—so that the cost of such improvement would generally exceed the benefit obtained. Greater effects on the texture of soils are derived from less quantities of calcareous earth, besides obtaining the more valuable operation of its other powers.

Every substance that is open enough for air to enter, and the particles of which are not absolutely impenetrable, must absorb moisture from the atmosphere. Aluminous earth reduced to an impalpable powder, has strong absorbing powers. But this is not the form in which such soils can act—and a close and solid clay will scarcely admit the passage of air or water, and therefore cannot absorb much moisture except by its surface. Through sandy soils, the air passes freely; but most of its particles are impenetrable by moisture, and therefore these soils are also extremely deficient in absorbent power. Calcareous earth, by rendering clay more open to the entrance of air, and closing partially the too open pores of sandy soils, increases the absorbent powers of both. To increase that power in any soil, is to enable it to draw supplies of moisture from the air, in the driest weather, and to resist more strongly the waste by evaporation, of light rains. A calcareous soil will so quickly absorb a hasty shower of rain, as to appear to have received less than adjoining land of different character: and yet if observed in summer when under tillage, some days after a rain, and when other adjacent land appears dry on the surface, the part made calcareous will still show the moisture remaining, by its darker color. All the effects from this power of calcareous manures may be observed within a few years after their application—though none of them so strongly marked, as they are on lands made calcareous by nature, and in which, time has aided and perfected the operation. These soils present great variety in their proportions of sand and clay—yet the most clayey is friable enough, and the most sandy, firm enough, to be considered soils of good texture: and they resist the extremes of both wet and dry seasons, better than any other soils whatever. Time, and the increase of vegetable matter, will bring those qualities to the same perfection, in soils made calcareous by artificial means.

The subsequent gradual accumulation of vegetable matter in soils to which calcareous manures have been applied, must also aid the improvement of their texture and absorbing power. The vegetable matter also darkens the color of the soil, which makes it warmer by more freely absorbing the rays of the sun.

Additional and practical proofs of all the powers of calcareous earth will be furnished, when its use and effects as manure will be stated. I flatter myself however, that enough has already been said both to establish, and account for, the different capacities of soils for improvement by putrescent manures. If the power of fixing manures in soils, has been correctly ascribed to calcareous earth, that alone is enough to show that soils containing that ingredient in sufficient quantity, must become rich—and that aluminous and silicious earths mixed in any proportions, can never form other than a steril soil.

The object of this essay is to treat only of calcareous earth (as before defined) as a manure, and not of pure lime, nor of manures in general. Still the nature of that which is properly my subject, is so intimately connected with some other kinds of manures, and is so liable to be confounded with others, which act very differently, that frequent references to both classes have been, and will be again necessary. To make such references more plain and useful, some general remarks and opinions will now be submitted as to the peculiar modes of the operation of various manures, and particularly of lime.

Until now, I have been careful to say but little of *pure lime*, for fear of my meaning being mistaken, from the usual practice of confounding it with calcareous earth—or of considering its first and later operations, as belonging to one and the same manure. The connexion between the manures is so intimate, yet their actions so distinct, that it is necessary to mark the points of resemblance as well as those of difference.

My own use of lime as a manure has not extended beyond a few acres; and I do not pretend to know any thing from experience, of its first or caustic effects: but Davy's simple and beautiful theory of its operation carries conviction with it, and in accordance with his opinions I shall state the theory, and thence attempt to deduce its proper practical use.

By a sufficient degree of heat, the carbonic acid is driven off from shells, limestone, or chalk, and the remainder is pure or caustic lime. In this state is has a powerful decomposing power on all

utrescent animal and vegetable matters, which exerts on every such substance in the soils to hich it is applied as manure. If the lime thus ieets with solid and inert vegetable matters, it astens their decomposition, renders them soluble, nd brings them into use and action as manure. ut such vegetable and animal matters as were lready decomposed, and fit to support growing lants, are injured by the addition of lime—as the hemical action which takes place between these odies, forms different compounds which are alays less valuable than the putrid or soluble maters were, before being acted on by the lime. *Agr. Chem. Lecture* 7.]

This theory of Davy's, will direct us to expect rofit from liming all soils containing much unroted and inert vegetable matter, as our acid woodand when first cleared, and perhaps worn fields, overed with broom grass—and to avoid the aplication of lime, or (what is the same thing,) to estroy previously its caustic quality by exposure the air, on all good soils containing soluble veetable or animal matters, and on all poor soils eficient in inert, as well as active nourishment or plants. The warmth of our climate so much ids the fermentation of all putrescent matters in oils, that it can seldom be required to hasten it by rtificial means: to check its rapidity is much more ecessary, to avoid the waste of manures in our ands. But in England, and still more in Scotland, he case is very different. There, the coldness nd moisture of the climate greatly retard the fermentation of the vegetable matter that falls on the and—so much so, that in certain situations the most favorable to such results, the vegetable cover s increased by the deposite of every successive ear, and forms those vegetable soils, which are alled *moor*, *peat*, and *bog* lands. Vegetable matter abounds in these soils, sometimes it even forms he greater bulk for many feet in depth—but it is nert, insoluble, and useless, and the soil is unable o bring any useful crop, though containing vegeable matter in such excess. Many millions of cres in Britain, are of the different grades of peat oils, of which not an acre exists in the eastern alf of Virginia. Upon this ground of the difference of climate, and its effects on fermentation, I educe the opinion that *lime* would be serviceable much more generally in Britain than here: and indeed that there are very few cases in which the caustic quality would not do our arable lands more harm than good. This is no contradiction of the great improvements which have been made on some farms by applying lime—because its caustic quality was seldom allowed to act at all. Lime is continually changing to the carbonate of lime, and in practice, no exact line of separation can be drawn between the transient effects of the one, and the later, but durable improvement from the other. Lime powerfully attracts the carbonic acid, of which it was deprived by heat, and that acid is universally diffused through the atmosphere (though in a very small proportion,) and is produced by every decomposing putrescent substance. Consequently caustic lime on land, is continually absorbing and combining with this acid; and with more or less rapidity, according to the manner of its application, is returning to its former state of mild calcareous earth. If spread as a top dressing on grass lands —or on ploughed land, and superficially mixed with the soil by harrowing—or used in composts with fermenting vegetable matter—the lime is probably completely carbonated, before its causticity can act on the soil. In no case can lime, applied properly as manure, long remain caustic in the soil. Thus most applications of lime are simply applications of calcareous earth, but acting with greater power at first, in proportion to its quantity, because more finely divided, and more equally distributed.

By adopting the views which have been presented of the action of calcareous earth, and of lime, as manures, and those which are generally received as to the mode of operation of other manures, the following table has been constructed, which may be found useful, though necessarily imperfect, and in part founded only on conjecture. The various particular kinds of manures are arranged in the supposed order of their power, under the several heads or characters to which they belong; and when one manure possesses several different modes of action, the comparative force of each is represented by the letters annexed—the letter *a* designating its strongest or most valuable agency, *b* the next strongest, and so on.

CLASSIFICATION OF MANURES.

Substances which form manures are either

| | |
|---|---|
| *Alimentary*, or serving as food for plants—as | Feathers, hair, woollen rags,<br>Pounded bones, (*b*)<br>All putrescent animal and vegetable substances, as<br>Dung,<br>Stable and farmyard manures, (*a*)<br>Straw, (*a*)<br>Green crops ploughed in. (*a*) |
| *Solvent* of alimentary manures—as | Quicklime, (*a*)<br>Potash and soap lie? (*a*)<br>Ashes not drawn? (*d*)<br>Paring and burning the surface of the soil. (*a*) |
| *Mordants*—serving to fix other manures in soils—as | Calcareous earth, including<br>Lime become mild by age, (*a*)<br>Chalk, (*a*)<br>Limestone gravel, (*a*)<br>Wood ashes, (*b*)<br>Fossil shells, (*a*)<br>Marl (a calcareous clay,) (*a*)<br>Old mortar. |
| *Neutralizing* acids—as | All calcareous manures, (*b*)<br>Quicklime, (*b*)<br>Potash and soap lie, (*b*)<br>Wood ashes. (*c*) |
| *Mechanical*, or improving by altering the texture of soil—as | All calcareous manures, (*c*)<br>Marl, (*b*)<br>Clay,<br>Sand,<br>Fermenting vegetable manures, (*b*)<br>Green manures, (*b*)<br>Unfermented litter. (*b*) |
| *Stimulating*—as | Nitre?<br>Common salt? |
| *Specific*, or furnishing ingredients necessary for particular plants—as | Sulphate of lime, or gypsum, (for clover,)<br>Phosphate of lime, (for wheat) in<br>Bones, (*a*) and<br>Drawn ashes, (*a*)<br>Salt? |

# PART II—*Practice.*

## CHAPTER IX.

GENERAL OBSERVATIONS ON MARL AND LIME. EFFECTS OF CALCAREOUS MANURES ON ACID SANDY SOILS, NEWLY CLEARED.

PROPOSITION 5. *Calcareous manures will give to our worst soils a power of retaining putrescent manures, equal to that of the best—and will cause more productiveness, and yield more profit, than any other improvement practicable in Lower Virginia.*

The theory of the constitution of fertile and barren soils, has now been regularly discussed: it remains to show its practical application, in the use of calcareous earth as a manure. If the opinions which have been maintained are unsound, the attempt to reduce them to practice will surely expose their futility: and if they pass through that trial, agreeing with, and confirmed by facts, their truth and value must stand unquestioned. The belief in the most important of these opinions, (the incapacity of poor soils for improvement, and its cause;) directed the commencement of my use of calcareous manures; and the manner of my practice has also been directed entirely by the views which have been exhibited. Yet in every respect the results of practice have sustained the theory of the action of calcareous manures—unless there be found an exception in the damage which has been caused by applying too heavy dressings to weak lands.

My use of calcareous earth as manure, has been almost entirely confined to that form of it which is so abundant in the neighborhood of our tide-waters—the beds of *fossil shells*, together with the earth with which they are found mixed. The shells are in various states—in some beds generally whole, and in others, reduced nearly to a coarse powder. The earth which fills their vacancies, and serves to make the whole a compact mass, in most cases is principally silicious sand, and contains no putrescent or valuable matter, other than the calcareous. The same effects might be expected from calcareous earth in any other form, whether chalk, limestone gravel, wood ashes, or lime—though the two last have other qualities besides the calcareous. During the short time that lime can remain *quick* or *caustic*, after being applied as manure, it exerts (as before stated) a solvent power, sometimes beneficial and at others hurtful, which has no connexion with its subsequent and permanent action as calcareous earth.

These natural deposites of fossil shells are commonly, but very improperly, called *marl*. This misapplied term is particularly objectionable, because it induces erroneous views of this manure. Other earthy manures have long been used in England under the name of marl, and numerous publications have described their general effects, and recommended their use. When the same name is given here to a different manure, many persons will consider both operations as similar, and perhaps may refer to English authorities for the purpose of testing the truth of my opinions, and the results of my practice. But no two operations called by the same name, can well differ more. The process which it is my object to recommend, is simply *the application of calcareous earth in any form whatever, to soils wanting that ingredient*, and generally quite destitute of it: and the propriety of the application depends entirely on our knowing that the manure contains calcareous earth, and what proportion, and that the soil contains none. In England, the most scientific agriculturists apply the term *marl* correctly to a *calcareous clay*, of peculiar texture: but most authors, as well as mere cultivators, have used it for any smooth soapy clay, which may, or may not have contained, so far as they knew, any proportion of calcareous matter. Indeed, in most cases, they seem unconscious of the presence, as well as of the importance of that ingredient, by not alluding to it when attempting most carefully to point out the characters by which marl may be known. Still less do they inquire into the deficiency of calcareous earth in soils proposed to be marled—but apply any earths which either science or ignorance may have called *marl*, to any soils within a convenient distance—and rely upon the subsequent effects to direct whether the operation shall be continued or abandoned. Authors of the highest character, (as Sinclair and Young, for example,) when telling of the practical use, and valuable effects of marl, omit giving the strength of the manure, and generally even its nature—and in no instance have I found the ingredients of the soil stated, so that the reader might learn what kind of operation really was described, or be enabled to form a judgement of its propriety. From all this, it follows that though what is called *marling* in England may sometimes (though very rarely, as I infer) be the same chemical operation on the soil that I am recommending, yet it may also be, either applying clay to sand, or clay to chalk, or true marl to either of those soils—and the reader will generally be left to guess in every separate case, which of all these operations is meant by the term *marling*. For these reasons, the practical knowledge to be gathered from all this mass of written instruction on marling, will be far less abundant, than the inevitable errors and mistakes. The recommendations of marl by English authors, induced me very early to look to what was here called by the same name, as a means for improvement: but their descriptions of the manure convinced me that our marl was nothing like theirs, and thus actually deterred me from using it, until other views instructed me that its value did not depend on its having "a soapy feel," or on any mixture of clay whatever. [Appendix. G.]

Nevertheless, much valuable information may be obtained from these same works, on calcareous manure, or on marl, (in the sense it is used among us)—but under a different head, viz. *lime*. This

manure is generally treated of with as little clearness or correctness, as is done with marl: but the reader at least cannot be mistaken in this, that the ultimate effect of every application of lime, must be to make the soil more calcareous—and to that cause solely are to be imputed all the long-continued beneficial consequences, and great profits, which have been derived from liming. But excepting this one point, in which we cannot be misled by ignorance, or want of precision, the mass of writings on lime, as well as on calcareous manures in general, will need much sifting to yield instruction. The opinions published on the operation of lime, are so many, so various, and contradictory, that it seems as if each author had hazarded a guess, and added it to a compilation of those of all who had preceded him. For a reader of these publications to be able to reject all that is erroneous in reasoning, and in statements of facts—or inapplicable, on account of difference of soil, or other circumstances—and thus obtain only what is true, and valuable—it would be necessary for him first to understand the subject better than most of those whose opinions he was studying. It was not possible for them to be correct, when treating (as most do) of *lime* as one kind of manure, and every different form of the *carbonate of lime*, as so many others. Only one distinction of this kind (as to operation and effects) should be made, and never lost sight of—and that is one of substance, still more than of name. Pure or quicklime, and carbonate of lime, are manures entirely different in their powers and effects. But it should be remembered that the substance that was *pure lime* when just burned, often becomes *carbonate of lime* before it is used, (by absorbing carbonic acid from the atmosphere,)—still more frequently before a crop is planted—and probably always, before the first crop ripens. Thus, it should be borne in mind that the manure spoken of as lime, is often at first, and always at a later period, neither more nor less than calcareous earth: that lime, which at different periods, is two distinct kinds of manure, is considered in agricultural treatises as only one: and to calcareous earth are given as many different names, all considered to have different values and effects, as there are different forms and mixtures of the substance presented by nature.

But however incorrect and inconvenient the term *marl* may be, custom has too strongly fixed its application for any proposed change to be adopted. Therefore, I must submit to use the word *marl* to mean beds of fossil shells, notwithstanding my protest against the propriety of its being so applied.

The following experiments are reported, either on account of having been accurately made, and carefully observed, or as presenting such results as have been generally obtained on similar soils, from applications of fossil shells to nearly six hundred acres of Coggin's Point Farm. It has been my habit to make written memoranda of such things; and the material circumstances of these experiments were put in writing at the time they occurred, or not long after. Some of the experiments were, from their commencement, designed to be permanent, and their results to be measured as long as circumstances might permit. These were made with the utmost care. But generally, when precise amounts are not stated, the experiments were less carefully made, and their results reported by guess. Every measurement stated of land, or of crop, was made in my presence. The average strength of the manure was ascertained by a sufficient number of analyses—and the quantity applied was known by measuring some of the loads, and having them dropped at certain distances. At the risk of being tedious, I shall state every circumstance supposed to affect the results of the experiments—and the manner of description, and of reference, necessary to use, will require a degree of attention that few readers may be disposed to give, to enable them to derive the full benefit of these details. But however disagreeable it may be to give to them the necessary attention, I will presume to say that these experiments deserve it. They will present practical proofs of what otherwise would be but uncertain theory—and give to this essay its principal claim to be considered useful and valuable.

When these operations were commenced, I knew of no other experiments having been made with fossil shells, except two, which had been tried long before, and were considered as proving the manure too worthless to be resorted to again.* Inexperience, and the total want of any practical guide, caused my applications, for the first few years, to be frequently injudicions, particularly as to the quantities laid on. For this reason, these experiments show what was actually done, and the effects thence derived, and not what better information would have directed, as the most profitable course.

The measurements of corn that will be reported were all made at the time and place of gathering.

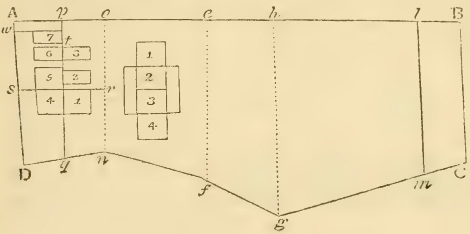
* The earliest of these old experiments was made at Spring Garden in Surry, about 1775. The extent marled was eight or ten acres, on poor sandy land. Nothing is now known of the effects for the first twenty-five or thirty years, except that they were too inconsiderable to induce a repetition of the experiment. The system of cultivation was as exhausting as was usual during that time. Since 1812, the farm has been under mild and improving management generally. No care has been taken to observe the progress either of improvement or exhaustion on the marled piece: but there is no doubt but that the product has continued for the last fifteen years better than that of the adjacent land. Mr. Francis Ruffin, the present owner of the farm, believed that the product was not much increased in favorable seasons; but when the other land suffered either from too much wet, or dry weather, the crop on the marled land was comparatively but slightly injured. The loose reports that have been obtained respecting this experiment, are at least conclusive in showing the permanency of the effects produced.

The other old experiment referred to, was made at Aberdeen, Prince George county, in 1803, by Mr Thomas Cocke. Three small spots (neither exceeding thirty yards square,) of poor land, kept before and since generally under exhausting culture, were covered with this manure. He found a very inconsiderable early improvement, which he thought altogether an inadequate reward for the labor of applying the marl. The experiment being deemed of no value, was but little noticed until the commencement of my use of the same manure. On examination, the improvement appeared to have increased greatly on two of the pieces, but the third was evidently the worse for the application. For a number of years after making this experiment, Mr. Cocke considered it as giving full proof of the worthlessness of the manure. But more correct views of its mode of operation have since induced him to recommence its use, and no one has met with more success, or produced more valuable improvements.

The measure used for all except very small quantities, was a barrel holding five bushels when filled level, and which being filled twice with ears of corn, well shaken to settle them, and heaped, was estimated to make five bushels of grain—and the products will be reported in *grain*, according to this estimate. This mode of measurement will best serve for comparing results—but in most cases it is far from giving correctly the actual quantity of dry and sound grain, for the following reasons. The common large soft grained white corn was the kind cultivated, and which was always cut down for sowing wheat before the best matured was dry enough to grind, or even to put up in cribs; and when the ears from the poorest land were in a state to lose considerably more by shrinking. Yet, for fear of some mistake occurring if measurements were delayed until the crop was gathered, these experiments were measured when the land was ploughed for wheat in October. The subsequent loss from shrinking would of course be greatest on the corn from the poorest and most backward land, as there, most defective and unripe ears would always be found. Besides, every ear, however imperfect or rotten, was included in the measurement. For these several reasons, the actual increase of product on the marled land was always greater than will appear from the comparison of quantities measured: and from the statements of all such early measurements, there ought to be allowed a deduction, varying from ten per cent. on the best and most forward corn, to thirty per cent. on the latest and most defective. Having stated the grounds of this estimate, practical men can draw such conclusions as their experience may direct, from the dates and amounts of the actual measurements that will be reported. Some careful trials of the amount of shrinkage in particular experiments will be hereafter stated.

No grazing has been permitted on any land from which experiments will be reported, unless it is specially stated.

As most of the experiments on new land were made on a single piece of twenty-six acres a general description or plan of the whole will enable me to be better understood, as well as to be more concise, by references being made to the annexed figure. It forms part of the ridge lying between James River and the nearest stream running into Powell's Creek. The surface is nearly level. The




soil in its natural state very similar throughout, but the part next to the line B C somewhat more sandy, and more productive in corn, than the part next to A D—and in like manner, it is lighter along A , than nearer to D *f*. The whole soil, a gray silicious acid loam, not more than two inches deep at first, resting on a yellowish sandy subsoil from one to two feet deep, when it changes to clay. Natural growth mostly pine—next in quantity, oaks of different kinds—a little of dogwood and chinquepin—whortleberry bushes throughout in plenty. The quality of the soil is better than the average of ridge lands in general.

*Experiment* 1.

The part B C *g h*, about eleven acres, grubbed and cut down in the winter of 1814–15—suffered to lie three years with most of the wood and brush on it. February 1818, my earliest application of marl was made on B C *m l*, about $2\frac{1}{2}$ acres. Marl, $\frac{33}{100}$ of calcareous earth, and the balance silicious sand, except a very small proportion of clay: the shelly matter finely divided. Quantity of marl to the acre, one hundred and twenty-five to two hundred heaped bushels. The whole B C *g h* coultered, and planted in its first crop of corn.

*Results.* 1818. The corn on the marled land, evidently much better—supposed difference, forty per cent.

1819. In wheat. The difference as great, perhaps more so—particularly to be remarked from the commencement to the end of the winter, by the marled part preserving a green color, while the remainder was seldom visible from a short distance, and by the spring, stood much thinner, from the greater number of plants having been killed. The line of separation very perceptible through both crops.

1820. At rest. During the summer marled all B C *g h*, at the rate of five hundred bushels, without excepting the space before covered, and a small part of that made as heavy as one thousand bushels, counting both dressings. The shells now generally coarse—average strength of the marl, $\frac{47}{100}$ of calcareous earth. In the winter after, ploughed three inches deep as nearly as could be, which made the whole new surface yellow, by bringing barren subsoil to the top.

*Results continued.* 1821. In corn. The whole a remarkable growth for such a soil. The oldest (and heaviest) marled piece better than the other, but not enough so to show the dividing line. The

average product of the whole supposed to have been fully twenty-five bushels to the acre.

1822. In wheat—and red clover sowed on all the old marling, and one or two acres adjoining. A severe drought in June killed the greater part of the clover, but left it much the thickest on the oldest marled piece, so as again to show the dividing line, and to yield in 1823, two middling crops to the scythe—the first that I had known obtained from any acid soil, without high improvement from putrescent manures.

1823. At rest—nothing taken off, except the clover on B C *m l*.

1824. In corn—product seemed as before, and its rate may be inferred from the actual measurements on other parts, which will be stated in the next experiment, the whole being now cleared, and brought under like cultivation.

*Experiment* 2.

The part *e f n o*, cleared and cultivated in corn at the same times as the preceding—but treated differently in some other respects. This had been deprived of nearly all its wood, and the brush burnt, at the time of cutting down—and its first crop of corn (1818) being very inferior, was not followed by wheat in 1819. This gave two years of rest before the crop of 1821—and five years rest out of six, since the piece had been cut down. As before stated, the soil rather lighter on the side next to *o e*, than *n f*.

March, 1821. A measured acre near the middle, covered with six hundred bushels of calcareous sand ($\frac{20}{100}$,) the upper layer of another body of fossil shells.

*Results*. 1821. In corn. October—the four adjoining quarter acres, marked 1, 2, 3, 4, extending nearly across the piece, two of them within, and two without the marled part, measured as follows:

| | | | |
|---|---|---|---|
| Not marled, | No. 1, | $6\frac{1}{8}$ | average to the acre $22\frac{1}{2}$ bushels of grain. |
| Do. | No. 4, | $5\frac{1}{8}$ | |
| Marled, | No. 2, | $8\frac{1}{2}$ | average $33\frac{1}{4}$ bushels. |
| Do. | No. 3, | $8\frac{1}{8}$ | |

The remainder of this piece was marled before sowing wheat in 1821.

1823. At rest.

1824. In corn—distance $5\frac{1}{2}$ by $3\frac{1}{4}$ feet, making 2436 stalks to the acre. October 11th, measured two quarter acres very nearly coinciding with Nos. 2 and 3 in the last measurement. They now made

| | | |
|---|---|---|
| No 2. 7 bushels $3\frac{1}{4}$pecks, or per acre, - - | 31.1 | average $31.2\frac{1}{2}$ |
| No 3. 8 bushels, - - | 32 | |
| Average in 1821, - - - | | 33.1 |

*Experiment* 3.

The part *e f g h* was cut down in January, 1821, and the land planted in corn the same year. The coultering and after-tillage very badly executed, on account of the number of whortleberry and other roots. As much as was convenient was marled at six hundred bushels ($\frac{37}{100}$) and the dressing limited by a straight line. Distance of corn $5\frac{1}{2}$ by $3\frac{1}{2}$ feet—2262 stalks to the acre.

*Results*. 1821. October—on each side of the dividing line, a piece of twenty-eight by twenty-one corn hills measured as follows:

| | | |
|---|---|---|
| No. 1. 588 stalks, not marled, 2 bushels, equal to | | $7\frac{3}{4}$ the acre |
| No. 2. 588 stalks, marled, | $4\frac{1}{4}$ | $16\frac{5}{8}$ .... |

1822. In wheat, the remainder having been previously marled.

1823. At rest. During the following winter it was covered with a second dressing of marl at 250 bushels ($\frac{45}{100}$) making 850 bushels to the acre altogether.

1824. In corn. Two quarter acres, chosen as nearly as possible on the same spaces that were measured in 1821, produced as follows:

| | |
|---|---|
| No. 1. 8 bushels, 2 pecks, or to the acre, | 34 |
| The same in 1821, before marling, | $7.3\frac{1}{4}$ |
| No. 2. 7 bushels, $2\frac{1}{2}$ pecks, or to the acre, | 30.2 |
| The same in 1821, after marling, | $16.1\frac{1}{2}$ |

1825. The whole twenty-six acres, including the subjects of all these experiments and observations, were in wheat. The first marled piece in Exp. 1, was decidedly the best—and a gradual decline was to be seen to the latest. I have never measured the product of wheat from any experiment, on account of the great trouble and difficulty that would be encountered. Even if the wheat from small measured spaces could be reaped and secured separately, during the heavy labors of harvest, it would be scarcely possible afterwards to carry the different parcels through all the operations necessary to show exactly the clean grain derived from each. But without any separate measurement, all my observations convince me, that the increase of wheat from marling, is at least equal to that of corn, during the first few years, and is certainly greater afterwards, in comparison to its product before using marl.

It was from the heaviest marled part of Exp. 1, that soil was analysed to find how much calcareous earth remained in 1826, (page 26.) Before that time the marl and soil had been well mixed by ploughing to the depth of five inches. One of the specimens of this soil then examined, consisted of the following parts—the surface, and consequently the undecomposed weeds upon it, being excluded.

1000 grains of soil yielded

| | |
|---|---|
| 769 | grains of silicious sand moderately fine, |
| 15 | finer sand, |
| 784 | |
| 8 | calcareous earth, from the manure applied, |
| 180 | finely divided clay, vegetable matter, &c. |
| 28 | lost in the process. |
| 1000 | |

This part, it has been already stated, was originally lighter than the general texture of the land.

*Experiment* 4.

The four acres marked A D *n o* were cleared in the winter 1823–4. The lines *p q* and *r s* divide the piece nearly into quarters. The end nearest A *p o* is lighter, and best for corn, and was still better for the first crop, owing to nearly that half having been accidentally burnt over. After twice

oultering, marl and putrescent manures were applied as follows; and the products measured, Oc-ober 11th, the same year.

*s q* not marled nor manured—produced on a uarter acre (No. 4.) of soft and badly filled corn,

| | | Bush. P. |
|---|---|---|
| bushels, or per acre | - - | 12. |

*q r* and *r p*, marled at 800 bushels ($\frac{45}{100}$) y three measurements of different pieces—

| | | | |
|---|---|---|---|
| Quarter acre (No. 1.) 5 bushels, very nearly, or | - - - - - - | | 19.3½ |
| Eighth (No. 2.) 2.3¼ | average | 24.1½ | 22.2 |
| Eighth (No. 3.) 3.1¼ | | | 27. |

*s t* manured at 900 to 1100 bushels to the cre, of which,

| | | |
|---|---|---|
| Quarter acre (No. 5.) with rotted corn stalks, from a winter cow-pen, gave | 5.2½ | 22.2 |
| Eighth (No. 6.) with stable manure, | 4.1¾ | 35.2 |
| Eighth (No. 7.) covered with the same heavy dressings of stable manure, and of marl also, gave | 4.2 | 36. |

*p w*, marled at 450 bushels, brought not so good crop as the adjoining *r p* at 800.

The distance was 5½ by 3¼ feet. Two of the uarter acres were measured by a surveyor's hain (as were four other of the experiments of 824,) and found to vary so little from the distance ounted by corn rows, that the difference was not vorth notice.

1825. In wheat: the different marked pieces eemed to yield in comparison to each other, pro-ortions not perceptibly different from those of he preceding crop—but the best not equal to any f the land marled before 1822, as stated in the st, 2nd, and 3rd experiments.

1827. Wheat on a very rough and imperfect ummer fallow. This was too exhausting a ourse (being three grain crops in the four shift otation,)—but was considered necessary to check he growth of bushes that had sprung from the roots still living. The crop was small, as might have been expected from its preparation.

1828. Corn—in rows five feet apart, and about three feet of distance along the rows, the seed being dropped by the step. Owing to unfavorable weather, and to insects and other vermin, not more than half of the first planting of this field lived—and so much replanting of course caused its product to be much less matured than usual, on the weaker land. All the part not marled, (and more particularly that manured,) was so covered by sorrel, as to require ten times as much labor in weeding as the marled parts, which, as in every other case, bore no sorrel. October 15th, gathered and measured the corn from the following spaces, which were laid off (by the chain) as nearly as could be, on the same land as in 1824.

The products so obtained, together with those of the previous and subsequent courses of tillage, will be presented below, in a tabular form, for the purpose of being more easily compared.

On the wheat succeeding this crop, clover seed was sowed, but very thinly, and irregularly. On the parts not marled, only a few yards width received seed, which the next year showed the expected result of scarcely any living clover. On the marled portions, the growth of clover was of middling quality: was not mowed nor grazed, but seed gathered by hand both in 1830 and 1831.

1832. Again in corn. It was soon evident that much injury was caused to the marled half *q p o n*, by the too great quantity applied. A considerable proportion of the stalks, during their growth, showed strongly the marks of disease from that cause, and some were rendered entirely barren. A few stalks only had appeared hurt by the quantity of marl, in 1828. On the lightly marled piece *w p*, and where the heaviest marling was accompanied by stable manure, there has appeared no sign of injury. The products were as follows:

| MARK. | DESCRIPTION. | PRODUCTS OF GRAIN PER ACRE. | | | | | |
|---|---|---|---|---|---|---|---|
| | | 1st course. 1824 October 11. | | 2nd course. 1828 October 15. | | 3rd course. 1832 October 26. | |
| | | Bush. | Pecks. | Bush. | Pecks. | Bush. | Pecks. |
| *q* | Not marled or manured, - - - - - - - | 12 | | 21 | 1 | 17 | 3½ |
| *r* 1 | Marled at 800 bushels, - - - - - - - | 19 | 3½ | 28 | 1½ | 28 | |
| *p* 2 | The same, - - - - - - - - - | 22 | 2 | 31 | 0¼ | 27 | 3 |
| *p* 3 | The same, - - - - - - - - - | 27 | | | | | |
| *t* 5 | Cow-pen manure, 900 to 1100 bushels, - - - | 22 | 2 | 25 | 2 | Better than *s q* | |
| *t* 6 | Stable manure, 900 to 1100 bushels, - - - - | 35 | 2 | 29 | | 28 | 1 |
| *t* 7 | Marl and stable manure, both as above, - - - | 36 | | 33 | 2 | 37 | 3½ |
| *p* | Marled at 450 bushels, - - - - - | Less than *r p* (800) | | Equal to *r p* | | 31 | 3 |

An accidental omission prevented the measurement of *s t* 5, in 1832.

This experiment has been made with much rouble, and every care bestowed to insure accu-acy. Still several causes have operated to affect he correctness of the results, and to prevent the omparative products showing the true rate of nprovement either from marl, or the putrescent nanure. These causes will be briefly stated.

1st. The quantity of marl (800 bushels) on *q r* nd *r p* is nearly double the amount that ought to ave been used: and this error has not only increased the expense uselessly, but has served to prevent the increase of product that would otherwise have taken place. This loss is proved by the gradual increase, and at last the greater product of *w p* marled at only 450 bushels.

2nd. The comparative superiority of all the marled ground to *s q* not marled, is lessened by this circumstance: most of the large logs, as well as all the small branches, were burnt upon the land, when it was cleared in 1824, before the ex-

periment was commenced; and the ashes have durably improved a spot where each of these large fires were made on *s q*, but have done no good, and perhaps have been injurious, to the marled pieces that were made sufficiently calcareous without the addition of ashes. At least, the good effect of ashes is very evident on *s q*, and has helped somewhat to increase all its measured products, and no such benefit has been visible on the marled parts.

3rd. The quantity of putrescent manure applied to *s t* (900 to 1100 bushels) was much too great both for experiment and profit: and the quantity, together with the imperfectly rotted state of the stable manure, has given more durability to the effect, than is to be expected from a more judicious and economical rate of manuring.

For these several reasons, it is evident that far more satisfactory results than even these, would have been obtained if only half as much of either marl or manure had been applied.

There are other circumstances to be considered, which if not attended to, will cause the comparative increase or decrease of product in this experiment to be misunderstood. It is well known tha[t] poor land put under tillage immediately after being cleared, as this was in 1824, will not yield near a[s] much as on the next succeeding course of crops. This increase, which depends merely on the effects of time, operates independently of all othe[r] means for improvement that the land may possess and its rate, in this experiment, may be fairly estimated by the increase on the piece *s q* from 182[4] to 1828. The increase here, where time onl[y] acted, was from 12 to $21\frac{1}{4}$ bushels: but as the cor[n] gathered here was always much the most imperfectly ripened, and would therefore lose the mos[t] by shrinking, I will suppose eight bushels to b[e] the rate of increase from time, and that so muc[h] of the product of all the pieces should be attribute[d] to that cause. Then to estimate alone the increased or diminished effects of marl, or manur[e] on the other pieces, eight bushels should be deducted from all the different applications, the estimate will stand thus:

| | 1824 | | | 1828 | | DEDUCT FOR TIME. | INCREASE. | | DECREASE. | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | B. | P. | | B. | P. | B. | B. | P. | B. | P. | |
| *q r* 1 | 19 | $3\frac{1}{2}$ | | 28 | $1\frac{1}{2}$ | 8 | 0 | 2 | —— | | From 800 bushels of marl. |
| *r p* 2 | 22 | 2 | 24 $1\frac{1}{2}$ | 31 | | 8 | —— | | 1 | $1\frac{1}{2}$ | —— 800 bushels of marl. |
| *r p* 3 | 27 | | | | | | | | | | |
| *s t* 5 | 22 | 2 | | 25 | | 8 | —— | | 5 | 2 | —— 1000 bushels of cow-pen manure. |
| *s t* 6 | 35 | 2 | | 29 | | 8 | —— | | 14 | 2 | —— 1000 bushels of stable manure. |

Even the piece covered with both marl and stable manure, (*w t*) shows according to this estimate a diminished effect equal to $10\frac{1}{2}$ bushels; which was owing to the marl not being able to combine with, and fix so great a quantity of manure, in addition to the vegetable matter left by its natural growth of wood. The piece *w p* marled at 450 bushels alone, has shown a steady increase of product at each return of tillage, and thereby has given evidence of its being the only improvement made in such manner as both judgement and economy would have directed.

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## CHAPTER X.

### EFFECTS OF CALCAREOUS MANURE ON ACID CLAY SOILS, RECENTLY CLEARED.

The two next experiments were made on another field of thirty acres of very uniform quality, marled and cleared in 1826, and the succeeding years. The soil is very stiff, close, and intractable under cultivation—seems to contain scarcely any sand—but in fact, about one-half of it is composed of silicious sand, which is so fine, when separated, as to feel like flour. Only a small proportion of the sand is coarser than this state of impalpable powder. Aluminous earth of a dirty fawn color forms nearly all of its remaining ingredients. Before being cleared, the soil is not an inch deep, and all below for some feet is apparently composed of the like parts of clay and fin[e] sand. This is decidedly the most worthless kin[d] of soil, in its natural state, that our district furnishes. It is better for wheat than for corn, though its product is contemptible in every thing: it is difficult to be made wet, or dry—and therefore suffers more than other soils from both dry and we[t] seasons, but especially from the former. It is almost always either too wet or too dry for ploughing—and sometimes it will pass through bot[h] states, in two or three clear and warm days. I[f] broken up early in winter, the soil, instead of being pulverized by frost, like most clay lands, run[s] together again by freezing and thawing—and b[y] March, will have a sleek (though not a ver[y] even) crust upon the surface, quite too hard t[o] plant on before a second ploughing. The natura[l] growth is principally white and red oaks, a smalle[r] proportion of pine, and whortleberry bushe[s] throughout.

*Experiment 5.*

On one side of this field a marked spot of thirty-five yards square was left out, when the adjoinin[g] land was marled at the rate of five hundred to si[x] hundred bushels ($\frac{37}{100}$) to the acre. Paths for th[e] carts were opened through the trees, and the mar[l] dropped and spread in January, 1826: the lan[d] cleared the following winter. Most of the woo[d] was carried off for fuel—the remaining logs an[d] brush burnt on the ground, as usual, at such distances as were convenient to the laborers. Thi[s]

ırt was perhaps the poorer, because wood had reviously been cut here for fuel; though only a w trees had been taken, here and there, without ny thing like clearing the land.

*Results.* 1827. Planted in corn the whole re-nt clearing of fifteen acres—all marled, except ıe spot left out for experiment: broken up late ıd badly, and worse tilled, as the land was gene-ılly too hard, until the season was too far ad-ınced to save the crop. The whole product so nall, that it was useless to attempt to measure ıe products. The difference would have been ıly between a few imperfect ears on the marled round, and still less—indeed almost nothing—on ıat not marled.

1828. Again in corn: as well broken and cul-vated as usual for such land. October 18th—cut ɔwn four rows of corn running through the land ɔt marled, and eight others, alongside on the ıarled—all fifty feet in length. The rows had een laid off for five and a half feet—but were und to vary a few inches—for which the proper lowance was made, by calculation. The spaces ıken for measurement were caused to be so small, y a part of the corn having been inadvertently ıt down and shocked, just before. The ears were ıelled when gathered; and the products, mea-ıred in a vessel which held (by trial) $\frac{1}{80}$ of a ıshel, were as follows:

On land not marled
rows, average 5 feet, and 50 in length, (500 square feet) - - $13\frac{1}{2}$ measures,
to the acre, - - $7\frac{1}{4}$ bushels.
On adjoining marled land
rows, average 5 feet $1\frac{1}{2}$ inches by 50 feet = 512 square feet, - - $25\frac{3}{4}$ measures,
to the acre, - - $13\frac{1}{2}$ bushels.
next rows, 5 feet $4\frac{1}{2}$ inches by 50 = 537 square feet, - - - $27\frac{1}{2}$ measures,
to the acre, - - 14 bushels.

1829. In wheat.
1830. At rest—the weeds, a scanty cover.
1831. In corn. October 20th—measured by ıe chain equal spaces, and gathered and measured ıeir products. The corn not marled was so im-ırfectly filled, that it was necessary to shell it, for ıirly measuring the quantity. The marled par-ıls, being of good ears generally, were measured usual, by allowing two heaped measures of ırs, for one of grain.

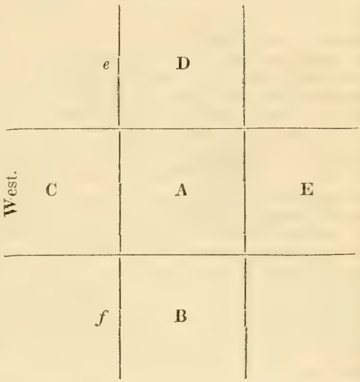
On land not marled
3 square yards made - 3 gallons,
to the acre, - - - 5 bushels.

On marled land close adjoining on one side,
3 square yards made rather more than 6 gal-lons—to the acre, - - 10 bushels.
3 square yards on another side, made not quite 8 gallons, or to the acre, - 12 bushels.

The piece not marled coincided with that mea-ıred in 1828, as nearly as their difference of size ıd shape permitted—as did the last named marl-piece, with the two of 1828. The last crop ıas greatly injured by the wettest summer that I ıve ever known, which has caused the decrease product exhibited in this experiment—which ıll be best seen in this form:

| | *Product of grain to the acre.* | | | |
|---|---|---|---|---|
| | 1828. October 18. | | 1831. October 20. | |
| | Bush. | Pecks. | Bush. | Pecks. |
| Not marled, - - | 7 | 1 | 5 | 0 |
| Marled, (averaged,) | 13 | 3 | 11 | 0 |

*Experiment* 6.




The remainder of the thirty acres, was grubbed during the winter 1826-7—marled the next summer at five hundred to six hundred bushels the acre: marl $\frac{40}{100}$. A rectangle (A) 11 by 13 poles, was laid off by the chain and compass, and left without marl. All the surrounding land supposed to be equal in quality with A—and all level, except on the sides E and B, which were partly sloping, but not otherwise different. The soil suited to the general description given before—no natural difference known or suspected, between the land on which Exp. 5 was made, and this, except that the latter had not been robbed of any wood for fuel, before clearing. The large trees (all more than ten inches through,) were belted, and the smaller cut down in the beginning of 1828, and all the land west of the line *e f* was planted in corn. As usual, the tillage bad, and the crop very small. The balance lying east of *e f*, was coultered once, but as more labor could not be spared, nothing more was done with it until the latter part of the winter 1829, when it was broken by two-horse ploughs, oats sowed and covered by trowel ploughs—then clover sowed, and a wooden-tooth harrow passed over to cover the seed, and to smooth down, in some measure, the masses of roots and clods.

*Results.* 1829. The oats produced badly—but yielded more for the labor required, than corn would have done. The young clover on the marled land was remarkably good, and covered the surface completely. In the unmarled part, A, only two casts through had been sown, for comparison, as I knew it would be a waste of seed. This looked as badly as had been expected.

1830. The crop of clover would have been con-

sidered excellent for good land, and most extraordinary for so poor a soil as this. The strips sowed through A, had but little left alive, and that scarcely of a size to be observed, except one or two small tufts, where I supposed some marl had been deposited by the cleaning of a plough, or that ashes had been left, from burning the brush. The growth of clover was left undisturbed until after midsummer, when it was grazed by my small stock of cattle, but not closely.

1831. Corn on the whole field. October 20th, measured carefully half an acre (10 by 8 poles) in A, the same in D, and half as much (10 by 4) in E. No more space could be taken on this side, for fear of getting within the injurious influence of the contiguous woods. No measurement was made on the side B, because a large oak, which belting had not killed, affected its product considerably. Another accidental circumstance prevented my being able to know the product of the side C, which however was evidently and greatly inferior to all the marled land on which oats and clover had been raised. This side had been in corn, followed by wheat, and then under its spontaneous growth of weeds. The corn on each of the measured spaces was cut down, and put in separate shocks—and on Nov. 25th, when well dried, the parcels were *shucked* and measured, before being moved. We had then been gathering and storing the crop, for more than fifteen days—and therefore these measurements may be considered as showing the amount of dry and firm grain, without any deduction being required for shrinkage.

| | | Bushels. | Pecks. |
|---|---|---|---|
| A (Half acre) made $7\frac{1}{4}$ bushels of ears, or of grain to the acre, | - | 7 | 1 |
| D (Half acre) $16\frac{3}{4}$ | - - | 16 | 3 |
| E (Quarter acre) 11 | - - | 22 | |

The sloping surface of the side E, prevented water from lying on it, and therefore it suffered less, perhaps not at all, from the extreme wetness of the summer, which evidently injured the growth on A and D, as well as of all the other level parts of the field.

1832. The field in wheat.

1833. In clover, which was grazed, though not closely, after it had reached its full growth.

1834. Corn, a year earlier than would have been permitted by the four-shift rotation. The tillage was insufficient, and made still worse by the commencement of severe drought before the last ploughing was completed, which was thereby rendered very laborious, and imperfect withal. The drought continued through all August, and greatly injured the whole crop of corn.

*Results continued.* October 22d. Marked off by a chain half an acre within the space A (8 by 10 poles) as much in D, and a quarter acre (10 by 4 poles) in each of the other three sides C, B, and E—having each of the last four spaces as near as could be to the outlines of the space A. The products carefully measured, (in the ears) yielded as follows:

| | B. | P. | |
|---|---|---|---|
| A, not marled, yielded | 6 | $0\frac{1}{2}$ | of grain, to the acre. |
| D marled, .......... | 19 | $3\frac{1}{2}$ | |
| E do. .......... | 20 | 1 | |
| C do. .......... | 20 | 2 | |
| B do. .......... | 20 | $1\frac{1}{2}$ | |

In comparing these products with those of th same land in 1831, stated above, it should be re membered that the corn formerly measured wa dry, while that of the last measurement had ye to lose greatly by shrinking. As after early ga thering, the corn from the poorest land of cours will lose most by drying, and as the ears on A were generally very defective and badly filled, i the measurement had been made in the sound and well dried grain of each parcel, the product of A could not have exceeded one-fourth of that of th surrounding marled land.

But though these differences of product presen the improvement caused by marling in a strikin point of view, this close and stubborn soil at bes is very unfit for the corn crop—and its highest va lue is found under clover, and in wheat on clover of which some proofs will be found in the next ex periment.

### *Experiment 7.*

Another piece of land of twenty-five acres, o soil and qualities similar to the last described (Exp 5 and 6,) was cleared in 1818, and about six acre marled in 1819, at about three hundred and fifty bushels. The course of cultivation was as fol lows.

1820—Corn—benefit from marl very unequa —supposed to vary between twenty-five and eigh ty per cent.

1821. Wheat—the benefit derived greater.

1822. At rest.

1823. Ploughed early for corn, but not planted. The whole marled at the rate of six hundred bush els ($\frac{40}{100}$,) again ploughed in August, and sowed in wheat in October. The old marled space, more lightly covered, so as to make the whole nearly equal.

1824. The wheat much improved.

1825 and 1826—at rest.

1827. Corn.

1828. In wheat, and sowed in clover.

1829—The crop of clover was heavier than any I had ever seen in this part of the country, excep on rich natural soil, where gypsum was used, and acted well. The growth was thick, but unequa in height, (owing probably to unequal spreading of the marl,)—it stood from fifteen to twenty-fou inches high. The first growth was mowed fo hay, and the second left to improve the land.

1830. The clover not mowed. Fallowed in August, and sowed wheat in October, after a se cond ploughing.

1831. The wheat was excellent—almost heav enough to be in danger of lodging. I suppose the product to be certainly twenty bushels—per haps twenty-five, to the acre.

As it had not been designed to make any exper iment on this land, the progress of improvemen was not observed with much care. But whateve were the intermediate steps, it is certain that th land, at first, was as poor as that forming the sub jects of the two preceding experiments in th unimproved state, (the measured products c which have been given)—and that its last cro was three or four times as great as could have bee obtained, if marl had not been applied. The pe culiar fitness of this kind of soil for clover afte marling, will require further remarks, and will b again referred to hereafter.

## CHAPTER XI.

### HE EFFECTS OF CALCAREOUS MANURES, ON ACID SOILS REDUCED BY CULTIVATION.

PROPOSITION 5. *Continued.*

My use of fossil shells has been more extensive 1 impoverished acid soils, than on all other kinds, id has never failed to produce striking improve-ent. Yet it has unfortunately happened, that e two experiments made on such land with most ire, and on which I relied mainly for evidence of e durable and increasing benefit from this ma-ire, have had their effects almost destroyed, by e applications having been made too heavy. hese experiments, like the 4th, and 6th, al-ady reported, were designed to remain without ly subsequent alteration, so that the measure-ent of their products once in every succeeding tation, might exhibit the progress of improve-ent under all the different circumstances. As danger was then feared from such a cause, arl was applied heavily, that no future addition ight be required: and for this reason, I have to port my greatest disappointments exactly in ose cases where the most evident success and creasing benefits had been expected. However, ese failures will be stated as fully as the most iccessful results—and they may at least serve to arn from the danger, if not to show the greatest rofits of marling.

It should be observed that the general rotation crops pursued on the farm, on all land not re-ntly cleared, was that of four shifts, (corn, wheat, id then the land two years at rest and not grazed,) iough some exceptions to this course will be re-arked in some of the experiments.

*Experiment* 8.

Of a poor silicious acid loam, seven acres were arled at the rate of only ninety bushels ($\frac{37}{100}$) to ie acre: laid on and spread early in 1819.

*Results.* 1819. In corn—the benefit too small be generally perceptible, but could be plainly istinguished along part of the outline, by com-aring with the part not marled.

1820. Wheat—something better—and the ef-ct continued to be visible on the weeds following, ntil the whole was more heavily marled in 1823.

*Experiment* 9.

In the same field, on soil as poor and more indy than the last described, four acres were arled at one hundred and eighty bushels ($\frac{37}{100}$,) larch 1819. A part of the same was also cover-l heavily with rotted barn-yard manure, which so extended through similar land not marled. his furnished for observation, land marled only—ianured only—marled and manured—and some ithout either. The whole space, and more ad-ining, had been manured five or six years before y summer cow-pens, and stable litter—of which appearance remained after two years.

*Results.* 1819. In corn. The improvement om marl very evident—but not to be distinguish-l on the part covered also by manure, the effect the latter so far exceeding that of the marl,

1820. In wheat. 1821 and 1822, at rest.

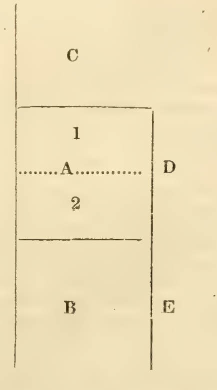
1823. In corn—$5\frac{1}{2}$ by $3\frac{1}{4}$ feet—The following ieasurements were made on adjoining spaces on October 10th. The shape of the ground did not admit of larger pieces, equal in all respects, being measured, as no comparison of products had been contemplated at first, otherwise than by the eye.

| | | Bush. | Qts. |
|---|---|---|---|
| From the part not marled— | | | |
| 414 corn-hills made 75 quarts--or per acre, | | 13 | 26 |
| Marled only— | | | |
| 414 | 100 | 18 | 12 |
| Manured only— | | | |
| 490 | 105 | 15 | 5 |
| Marled and manured— | | | |
| 490 | 130 | 20 | 20 |

The growth on the part both marled and manured was evidently inferior to that of 1819: this was to be expected, as this small quantity of calcareous earth was not enough to fix half so much putrescent manure—and of course, the excess was as liable to waste as if no marl had been used.

*Experiment* 10.

Twenty acres of sandy loam, on a sandy subsoil, covered in 1819 with marl of about $\frac{30}{100}$ average proportion of calcareous earth, and the balance silicious sand—at eight hundred bushels to the acre. This land had been long cleared, and much exhausted by cultivation: since 1813 not grazed, and had been in corn only once in four years, and as it was not worth sowing in wheat, had three years in each rotation to rest and improve by receiving all its scanty growth of weeds. The same course has been continued since 1819, except that wheat has regularly followed the crops of corn, leaving two years of rest, in four. This soil was lighter than the subject of any preceding experiment, except the ninth. On a high level part, surrounded by land apparently equal, a square of about an acre (A) was staked off, and left without marl—which that year's work brought to two sides of the square (C and D.)




*Results.* 1820. In corn: October 13th, three half acres of marled land were measured, and as many on that not marled, and close adjoining, and produced as follows:—

| *Not marled.* | | | *Marled.* | | |
|---|---|---|---|---|---|
| | Bush. | Pecks. | | Bush. | Pecks. |
| Half acre in A, | 7 | 1 | adjoining in C, | 12 | 3 |
| The same in A, | 7 | 1 | ..... D, | 13 | $3\frac{3}{4}$ |
| Half acre in B, | 7 | $2\frac{1}{2}$ | ..... E, | 15 | $0\frac{1}{2}$ |

The average increase being $12\frac{3}{4}$ bushels of grain to the acre: nearly 100 per cent. as measured, and more than 100, if the defective filling, and less matured state of the corn not marled, be considered. The whole would have lost more by shrinkage than is usual from equal products.

1821. The whole in wheat—much hurt by the wetness of the season. The marled part more than twice as good as that left out.

1822 and 1823. At rest. A good cover of carrot weeds and other kinds had succeeded the former growth of poverty grass and sorrel, and every appearance promised additional increase to the next cultivated crop. Nov. 1823, when the next ploughing was commenced, the soil was found to be evidently deeper, of a darker color, and firmer, yet more friable. The two-horse ploughs with difficulty (increased by the cover of weeds,) could cut the required depth of five inches, and the slice crumbled as it fell from the mould-board. But as the furrows passed into the part not marled, an immediate change was seen, and even *felt* by the ploughman, as the cutting was so much more easy, that care was necessary to prevent the plough running too deep—and the slices turned over in flakes, smooth and sleek from the mould-board, like land too wet for ploughing, which however was not the case. The marling of the field was completed, at the same rate, (eight hundred bushels,) which closed a third side (B) of the marked square. The fourth side was my neighbor's field.

1824. In corn. The newly marled part showed as early and as great benefit as was found in 1820—but was very inferior to the old, until the latter was ten or twelve inches high, when it began to give evidence of the fatal effects of using this manure too heavily. The disease thus produced became worse and worse, until many of the plants had been killed, and still more were so stunted, as to leave no hope of their being otherwise than barren. The effects will be known from the measurements, which were made nearly on the same ground as the corresponding marks in 1820, and will be exhibited in the table, together with the products of the succeeding rotations.—Besides the general injury suffered here in 1824, there were one hundred and three corn hills in one of the measured quarter acres (in C) or more than one sixth, entirely barren, and eighty-nine corn hills in another quarter acre (D.) In counting these none of the missing hills were included, as these plants might have perished from other causes. This unlooked for disaster diminished the previous increase gained by marling, by nearly one half; and the damage has since been still greater at each successive return of cultivation.

Just before planting the crops of 1832, straw and chaff very imperfectly rotted by exposure, and which contained no admixture of animal manure were applied at the rate of 800 bushels the acre to half the square without marl (A 1) and to all the surrounding marled land. The vegetable manure showed but slight benefit, until after all the worst effects of excessive marling had been produced; and the later operation of the manure served barely to prevent a still farther diminution being exhibited by the land injured by marl.

| MARK | DESCRIPTION. | PRODUCT IN SHELLED CORN, PER ACRE. | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | | 1st course 1820 Oct. 13. | | 2nd course 1824 Oct. 16. | | 3d course 1828 Oct. 13. | | 4th course 1832 Oct. 19. | |
| | | Bush. | pecks. | Bush. | pecks. | Bush. | pecks. | Bush. | pecks. |
| A | Not marled, | 14 | 2 | 16 | 1 | 11 | $3\frac{1}{2}$ | 9 | 3 |
| A 1 | After manuring, | | | | | | | 16 | 3 |
| B | Not marled until 1823, | 15 | 1 | 28 | | 19 | 2 | not measured. | |
| C | Marled in 1819—manured with chaff &c. in 1832, | 25 | | 19 | 2 | 15 | | 18 | |
| D | | 27 | $3\frac{1}{2}$ | 20 | | 19 | | 19 | $\frac{1}{2}$ |
| E | | 30 | 1 | not measured. | | not measured. | | not measured. | |

The crops of wheat were less injured than the corn.

For the crops of 1828, ploughed with three mules to each plough, from six to seven inches deep—seldom turning up any subsoil (which was formerly within three inches of the surface,) and the soil appearing still darker and richer than when preparing for the crops of 1824. The ploughing of the square not marled (A) no where exceeded six inches: yet that depth must have injured the land, as I can impute to no other cause the remarkable diminution of product, through four courses of the mild four-shift rotation. It was evident that a still greater depth of furrow was not hurtful to the marled land. A strip across the field in another place, was in 1828 ploughed eight inches deep for experiment, by the side of another of four inches, and the corn on the deepest ploughing was the best. Another was trench-ploughed twelve inches deep, without showing any perceptible difference either of product, or in the effects of damage from the excess of marl.

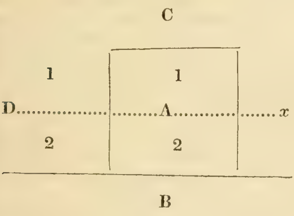
This square left without marl is the land formerly referred to (page 13) as showing a diminished product through three successive courses of the rotation recommended by the author of *Arator* as enriching. Since, another crop has been made and measured, and found to be still smaller than any previous. To whatever cause this continued falling off for 16 years may be attributed, it is at least a remarkable contradiction to the power of vegetable matter alone making poor land rich.

Much trouble has been encountered in attending to this experiment, and much loss of product submitted to, since its commencement, for the purpose of knowing the progress and extent of the

il caused by the excess of marl. But another rtion of the field, marled as heavily in 1824, and here equal damage was expected to ensue, has en entirely relieved by intermitting the corn crop 1828, sowing clover, which (by using gypsum) oduced well, and which was left to fall and rot the land. The next growth of corn (1832) was e from disease, and though irregular, seemed to e eye to amount to full twenty-five bushels to the re.

*Experiment* 11.

The ground on which this experiment was ade, was in the midst of nineteen or twenty res of soil apparently similar in all respects—vel, gray sandy loam, cleared about thirty years fore, and reduced as low by cultivation as such il could well be. The land that was marled and easured was about two hundred yards distant om Experiment 2, and both places are supposed have been originally similar in all respects. his land had not been cultivated since 1815, when was in corn—but had been once ploughed since, Nov. 1817, which had prevented broom grass om taking possession. The ploughing then was ur inches deep, and in five and a half feet beds, recommended in *Arator*. The growth in the ear 1820, presented but little except poverty grass, nning blackberry, and sorrel—and the land emed very little if at all improved by its five suc-ssive years of rest. A small part of this land as covered with calcareous sand $\frac{20}{100}$—quantity ot observed particularly, but probably about six undred bushels.




*Results.* 1821—Ploughed level, and planted in orn—distance $5\frac{1}{2}$ by $3\frac{1}{2}$ feet. The measurement f spaces nearly adjoining, made in October, was s follows:

3 by 25 corn hills, not marled, (A) made $2\frac{1}{8}$ bushels, or per acre, - - - $8\frac{3}{8}$ } very nearly.
3 by 25 corn hills, marled, (B) $5\frac{5}{8}$ $22\frac{1}{8}$

1822. At rest. Marled the whole, except a arked square of fifty yards, containing the space easured the preceding year. Marl $\frac{45}{100}$ and fine-y divided—three hundred and fifty bushels to the cre—from the same bed as that used for Experi-ent 4. In August, ploughed the land, and sow-d wheat early in October.

1823. Much injury sustained by the wheat from Iessian fly, and the growth was not only mean, ut very irregular—but it was supposed that the rst marled place was from fifty to one hundred per cent. better than the last, and the last superior to the included square not marled, in as great a proportion.

1824. Again in corn. The effects of disease from marling were as injurious here, both on the new and old part, as those described in Experiment 10. No measurement of products made, owing to my absence when the corn was cut down for sowing wheat.

1825. The injury from disease less on the wheat, than on the corn of the last year on the latest marling, and none perceptible on the oldest application. This scourging rotation of three grain crops in four years, was particularly improper on marled land, and the more so on account of its poverty.

1826. White clover had been sown thickly over forty-five acres, including this part, on the wheat, in January 1825. In the spring of 1826, it formed a beautiful green though low cover to even the poorest of the marled land. Marked spots, which were so diseased by over-marling, as not to produce a grain of corn or wheat, produced clover at least as good as other places not injured by that cause. The square, which had been sowed in the same manner, and on which the plants came up well, had none remaining by April 1826, except on a few small spots, all of which together would not have made three feet square. The piece not marled, white with poverty grass, might be seen, and its outlines traced at some distance by its strong contrast with the surrounding dark weeds in winter, or the verdant turf of white clover the spring before.

1827. Still at rest. No grazing allowed on the white clover.

1828. In corn—the land broken in January, five inches deep. October 14th made the following measurements.

In the square not marled 105 by $104\frac{1}{2}$ feet (thirty-six square yards more than a quarter of an acre,) made one barrel of ears—or of grain, to the acre,

| | Bush. | pecks. |
|---|---|---|
| | 9 | $1\frac{3}{4}$ |
| The same in 1821, | 8 | $1\frac{1}{2}$ |
| Gain, | 1 | $0\frac{1}{4}$ |

| | Bush. | pecks. |
|---|---|---|
| Old marling—105 by $104\frac{1}{2}$ feet—$2\frac{1}{4}$ barrels, | 22 | 2 |
| The same in 1821, | 22 | $0\frac{1}{2}$ |
| Gain, | | $1\frac{1}{2}$ |

New marling, 105 by $104\frac{1}{2}$ feet, on the side that seemed to be the most diseased, (D) $1\frac{1}{3}$ barrels—or nearly twelve bushels to the acre.

1832. Again in corn. Since 1826, the four-shift rotation had been regularly adhered to. Ploughed early in winter five inches deep, and again with two-horse ploughs just before planting, and after manuring the land above the dotted line D $x$. The manure was from the stable yard, the vegetable part of it composed of straw, corn-stalks, corn-cobs, and leaves raked from woodland—had been heaped in a wet state a short time before, and was still hot from its fermentation when carrying to the field. It was then about half rotted. The

rate at which it was applied was about 807 heaped bushels to the acre, which was much too heavy for profit. The corn on the oldest marling (B) showed scarcely a trace of remaining damage, while that on D 2 was again much injured. On the manured part of D, and C, the symptoms of disease began also to show early—but were so soon checked by the operation of the putrescent manure, that very little (if any) loss could have been sustained from that cause. The following table exhibits all the measured products for comparison.

| MARK. | DESCRIPTION. | PRODUCT IN GRAIN PER ACRE. 1st course 1821 Oct.— | | 2nd course 1824 | 3d course 1828 Oct. 14. | | 4th course 1832 Oct. 20. | |
|---|---|---|---|---|---|---|---|---|
| | | Bush. | pecks. | | Bush. | pecks. | Bush. | pecks. |
| A | Not marled, | 8 | 1½ | None measured, but the product of B much reduced by excess of marl, and D and C equally injured from the same cause. | 9 | 1¾ | 9 | 2½ |
| A 1 | ———— Manured in 1832, | | | | the same | | 23 | 3 |
| C | Marled in 1822 and manured in 1832, | | | | | | 31 | 1½ |
| B | Marled in 1821, | 22 | 0½ | | 22 | 2 | 25 | |
| D | Marled in 1822, | | | | 12 | | 17 | 3 |
| D 1 | The same—& manured in 1832 | | | | the same | | 34 | 3 |

The products of the spaces A and B, in 1828, were not only estimated as usual from the measurement of the corn in ears, (which estimated quantities are those in the table,) but they were also shelled on the day when gathered, and the grain then measured, and again some months after, when it had become thoroughly dry. Care was taken that there should be no waste of the corn, or other cause of inaccuracy. The result shows nearly double the loss from shrinking in the corn not marled, and of course a proportional gain in that marled, besides the increase which appears from the early measurement exhibited in the table. The grain of A, not marled, when first shelled, measured a very little more than the quantity fixed by estimate, and lost by shrinking 30 per cent. The marled grain, from B, measured at first above four per cent. more than the estimate—and after shrinking, fell below it so much as to show the loss to be 16 per cent.

The loss from shrinking in this case was more than usual, from the poverty and consequent backwardness of the part not marled, and the uncommonly large proportion of replanted corn on the whole.

The two last experiments, as well as the 4th, were especially designed to test the amount of increased product to be obtained from marling, and *to show* the regular addition to the first increase, which the theory promised at each renewal of tillage. As to the main objects, all the three experiments have proved failures—and from the same error of marling too heavily. Although for this reason, the results have shown so much of the injurious effects, still, taken altogether, the experiments prove clearly, not only the great immediate benefit of applying marl, but also its continued and increasing good effects, when applied in proper quantities.

### *Experiment* 12.

On nine acres of sandy loam, marled in 1819 at four hundred bushels ($\frac{25}{100}$) nearly an acre was manured during the same summer, by penning cattle: with the expectation of preserving the manure, double the quantity of marl, eight hundred bushels in all, was laid on that part. The field in corn in 1820—in wheat, 1821—and at rest 1822 and 1823.

*Results.* 1824. In corn, the second rotation after marling. The effects of the dung has not much diminished, and that part shows no damage from the quantity of marl, though the surrounding corn, marled only half as thickly, gave signs of general though very slight injury from that cause.

### *Experiment* 13.

Nearly two acres of loamy sand, was covered with farm-yard manure, and marl ($\frac{45}{100}$) at the same time, in the spring of 1822, and tended in corn the same year, followed by wheat. The quantity of marl not remembered—but it must have been heavy (say not less than six hundred bushels to the acre) as it was put on to fix and retain the manure, and I had then no fear of damage from heavy dressings.

*Result.* 1825. Again in corn—and except on a small spot of sand almost pure, no signs of disease from over-marling.

## CHAPTER XII.

### EFFECTS OF CALCAREOUS MANURES ON "FREE LIGHT LAND."

### *Experiment* 14.

The soil known in this part of the country by the name of "free light land" has so peculiar a character, that it deserves a particular notice. It belongs to the slopes and waving lands, between the ridges and the water courses, but has nothing of the durability which slopes of medium fertility sometimes possess. In its woodland state it would be called rich, and may remain productive for a few crops after clearing—but it is rapidly exhausted, and when poor, seems as unimprovable by vegetable manures as the poorest ridge lands. In its virgin state, this soil might be supposed to deserve the name of neutral—but its productive power is so fleeting, and acid growths and qualities so surely follow its exhaustion, that it must be inferred that it is truly an acid soil.

The subject of this experiment presents soil of this kind with its peculiar characters unusually

ell marked. It is a loamy sandy soil (the sand arse) on a similar subsoil of considerable depth. he surface waving—almost hilly in some parts. he original growth principally red oak, hickory, d dogwood—not many pines, and very little hortleberry. Cut down in 1816 and put in corn e next year. The crop was supposed to be enty-five bushels to the acre. Wheat succeed-, and was still a better crop for so sandy a soil—aking twelve to fifteen bushels, as it appeared anding. After a year of rest, and not grazed, e next corn crop of 1820, was evidently consi-rably inferior to the first—and the wheat of 1821, which however was a very bad crop from too wet season) could not have been more than five shels to the acre. In January 1820, a piece of acres was limed, at one hundred bushels the re. The lime being caught by rain before it was read, formed small lumps of mortar on the land, d produced no benefit on the corn of that year, t could be seen slightly in the wheat of 1821. he land again at rest in 1822 and 23, when it as marled, at six hundred bushels, ($\frac{37}{100}$) without itting the limed piece—and all sowed in wheat at fall. In 1824, the wheat was found to be im-oved by the marl, but neither that, nor the next 1828, was equal to its earliest product of wheat. he limed part showed injury from the quantity of anure in 1824, but none since. The field was ow under the regular four-shift rotation, and con-nued to recover—but did not surpass its first crop ntil 1831, when it brought rather more than thir- bushels of corn to the acre—being five or six ore than its supposed first crop.

Adjoining this piece, six acres of similar soil ere grubbed and belted in August 1826—marl at x hundred to seven hundred bushels ($\frac{37}{100}$) spread st before. But few of the trees died until the immer of 1827. 1828, planted in corn: the crop d not appear heavier than would have been ex-ected if no marl had been applied—but no part ad been left without, for comparison. 1829—heat. 1830, at rest. 1831, in corn, and the pro-uct supposed to be near or quite thirty-five bush-ls—or an increase of thirty-five or forty per cent. n the first crop. No measurement was made—ut the product was estimated by comparison with n adjacent piece, which measured thirty-one ushels, and which seemed to be inferior to this iece.

The operation of marl on this kind of soil, eems to add to the previous product very slowly, ompared with other soils—but it is not the less ffectual and profitable, in fixing and retaining the egetable matter accumulated by nature, which therwise would be quickly dissipated by cultiva-ion, and lost forever.

The remarkable open texture of the soil on which the last two experiments were tried will be vident from the following statement of the quan-ity and coarseness of the silicious sand contained.

1000 grains of this soil, taken in 1826 from the part that had been both limed and marled, was found to consist of
811 of silicious sand moderately coarse, mixed with a few grains of coarse shelly matter.
158—finely divided earthy matter, &c.
31—loss.

——
1000

At the same time, from the edge of the adjoining woodland which formed the next described clearing, and which had not then been marled, a specimen of soil was taken from between the depths of one and three inches—and found to consist of the following proportions. This spot was believed to be rather lighter than the other in its natural state.

865 grains of silicious sand, principally coarse—
107—finely divided earthy matter, &c.
28—loss.

——
1000
——

## CHAPTER XIII.

### EFFECTS OF CALCAREOUS MANURES ON EXHAUSTED ACID SOILS, UNDER THEIR SECOND GROWTH OF TREES.

PROPOSITION 5. *Continued.*

Not having owned much land under a second growth of pines, I can only refer to two experiments of this kind. The improvement in both these cases has been so remarkable, as to induce the belief that the old fields to be found on every farm, which have been exhausted and turned out of cultivation thirty or forty years, offer the most profitable subjects for the application of calcareous manures.

*Experiment* 15.

May 1826. Marled about eight acres of land under its second growth, by opening paths for the carts, ten yards apart. Marl $\frac{40}{100}$, put five hundred to six hundred bushels to the acre—and spread in the course of the summer. In August, belted slightly all the pines that were as much as eight inches through, and cut down or grubbed the smaller growth, of which there was very little. The pines (which were the only trees,) stood thick, and were mostly from eight to twelve inches in diameter—eighteen inches where standing thin. The land joined Exp. 14 on one side—but this is level, and on the other side joins ridge woodland, which soon becomes like the soil of Exp. 1. This piece, in its virgin state, was probably of a nature between those two soils—but more like the ridge soil, than the "free light land." No information has been obtained as to the state of this land when its former cultivation was abandoned. The soil, (that is, the depth which has since been turned by the plough,) a whitish loamy sand, on a subsoil of the same: in fact, all was subsoil before ploughing, except half an inch or three quarters, on the top, which was principally composed of rotted pine leaves. Above this thin layer, were the later dropped and unrotted leaves, lying loosely several inches thick.

The pines showed no symptom of being killed, until the autumn of 1827, when their leaves began to have a tinge of yellow. To suit the cultivation with the surrounding land, this piece was laid down in wheat for its first crop, in October 1827. For this purpose the few logs, the boughs, and grubbed bushes were heaped, but not burnt—the

grain sowed on the coat of pine leaves, and ploughed in by two-horse ploughs, in as slovenly a manner as may be supposed from the condition of the land—and a wooden-tooth harrow then passed over, to pull down the heaps of leaves, and roughest furrows.

*Results.* The wheat was thin, but otherwise looked well while young. The surface was again soon covered by the leaves dropping from the now dying trees. On April 2d 1828, most of the trees were nearly dead, though but few of them entirely. The wheat was then taller than any in my crop—and when ripe, was a surprising growth for such land, and such tillage.

1829 and 1830. At rest. Late in the spring of 1830 an accidental fire passed over the land—but the then growing vegetation prevented all of the older cover being burnt, though some was destroyed every where.

1831. In corn. The growth excited the admiration of all who saw it, and no one estimated the product so low as it actually proved to be. A square of four (two pole) chains, or four-tenths of an acre, measured on November 25th, yielded at the rate of thirty-one and three-eighths bushels of grain to the acre.

### *Experiment* 16.

In a field of acid sandy loam, long under the usual cultivation, a piece of five or six acres was covered by a second growth of pines thirty-nine years old, as supposed from that number of rings being counted on some of the stumps. The largest trees were eighteen or twenty inches through. This ground was altogether on the side of a slope, steep enough to lose soil by washing, and more than one old shallow gulley remained to confirm the belief of the injury that had been formerly sustained from that cause. These circumstances, added to all the surrounding land having been continued under cultivation, made it evident that this piece had been turned out of cultivation because greatly injured by tillage. It was again cut down in the winter of 1824–5—many of the trees furnished fence rails, and fuel—and the remaining bodies were heaped and burnt some months after, as well as the large brush. In August it was marled, supposed at six hundred bushels ($\frac{37}{100}$)—twice coultered in August and September, and sowed in wheat—the seed covered by trowel ploughs. The leaves and much of the smaller brush left on the ground, made the ploughing troublesome and imperfect. The crop (1826) was remarkably good—and still better were the crops of corn and wheat in the ensuing rotation, after two years of rest. On the last crop of wheat (1830) clover was sowed—and mowed for hay in 1831. The growth stood about eighteen inches high, and never have I seen so heavy a crop on sandy and acid soil, even from the heaviest dunging, the utmost care, and the most favorable season. The clover grew well in the bottoms of the old gullies, which are still plainly to be seen, and which no means had been used to improve, except such as all the land had received. Within two feet of the surface the subsoil of this land is of clay, which probably helped its growth of clover.

## CHAPTER XIV.

### EFFECTS OF CALCAREOUS MANURES ALONE, OR WITH GYPSUM, ON NEUTRAL SOILS.

PROPOSITION 5. *Continued.*

Applications of calcareous earth alone, to calcareous soils, are so manifestly useless, that only two experiments of that kind have been made, neither of which has had any improving effect that could be observed, in the twelve years that have since elapsed.

When calcareous manures have been applied to neutral soils, whether new or worn, no perceptible benefit has been obtained on the earliest crops. The subsequent improvement has gradually increased as would be expected from the power of fixing manures, attributed to calcareous earth. But however satisfactory these general results are to myself, they are not such as could be reported in detail, with any advantage to other persons. It is sufficiently difficult to make fair and accurate experiments, where early and remarkable results are expected. But no cultivator of a farm can bestow enough care and patient observation, to obtain true results from experiments that scarcely will show their first feeble effects in several years after the commencement. On a mere experimental farm, such things may be possible—but not where the main object of the farmer is profit from his general and varied operations. The effects of changes of season, of crops, of the mode of tillage—the auxiliary effects of other manures—and many other circumstances, would serve to defeat any observations of the progress of a slow improvement, though the ultimate result of the general practice might be abundantly evident.

Another cause of being unable to state with any precision the practical benefit of marling neutral soils, arises from the circumstance that nearly all the calcareous manure thus applied, has been accompanied by a natural admixture of gypsum: and though I feel confident in ascribing some effects to one, and some to the other of these two kinds of manure, yet this division of operation must rest merely on opinion, and cannot be received as certain, by any other than him who makes and carefully observes the experiments. Some of these applications will be described, that other persons may draw their own conclusions from them.

The cause of these manures being applied in conjunction was this. A singular bed of marl lying under Coggin's Point, and the only one within a convenient distance to most of the neutral soil, contains a very small proportion (perhaps about one per cent.) of gypsum, scattered irregularly through the mass, seldom visible, though sometimes to be met with in small crystals. The calcareous ingredient is generally about $\frac{53}{100}$—sometimes $\frac{60}{100}$. If this manure had been used before its *gypseous* quality was discovered, all its effects would have been ascribed to calcareous earth alone, and the most erroneous opinions might thence have been formed of its mode of operation.

What led me to suspect the presence of gypsum in this bed of fossil shells, was the circumstance that throughout its whole extent of near a mile along the river bank, this bed lies on another earth, of peculiar character and appearance, and which, in many places, exhibits gypsum in crystals of

rious sizes. This earth has evidently once been bed of fossil shells, like what still remains above but nothing now is left of the shells, except nu-erous impressions of their forms. Not the allest proportion of calcareous earth can be und—and the gypsum into which it must have en changed (by meeting with sulphuric acid, or phuret of iron,) has also disappeared in most ces; and in others, remains only in small quan-es—say from the smallest perceptible proportion, fifteen or twenty per cent. of the mixed mass. some rare cases, this gypseous earth is suffi-ntly abundant to be used profitably as manure, has been done, by Mr. Thomas Cocke of Tar-y, as well as myself. It is found in the great- quantity, and also the richest in gypsum, at ergreen, two miles below City Point. There gypsum frequently forms large crystals of va-d and beautiful forms. The distance that this l of gypseous earth extends is about seven miles, errupted only by some bodies of lower land, parently of a more recent formation by alluvion. the bed of gypseous marl above described, there regular layers of a calcareous rock, which was hard to use profitably for manure, and which used the greatest impediment to obtaining the ter part. This rock contains between eighty-e and ninety per cent. of pure calcareous earth, sides a little gypsum and iron. It makes excel-t lime for cement, mixed with twice its bulk of nd—and has been used for part of the brick-ork, and all the plastering of my present dwell-g house, and for several of my neighbors' houses. e whole body of marl also contains a minute oportion of some soluble salts, which possibly ay have some influence on the operation of the bstance, as manure, or cement.

Thus, from the examination of a single body of arl, there have been obtained not only a rich cal-reous manure, but also gypsum, and a valuable ment. Similar formations may perhaps be abun-nt elsewhere, and their value unsuspected, and ely to remain useless. This particular body of arl has no outward appearance of possessing en its calcareous character. It would be consider-, on slight observation, as a mass of gritty clay, no worth whatever. [Appendix H.]

This gypseous marl has been used on fifty-six res, most of which was neutral soil—and gener-y, if not universally, with early as well as per-anent benefits. The following experiments show sults more striking than have been usually ob-ned, but all agree in their general character.

*Experiment* 17.

1819. Across the shelly island numbered 3, in e examinations of soils, (page 19,) but where the nd was less calcareous, a strip of three quarters an acre was covered with muscle-shell marl. ouching this through its whole length, another rip was covered with gypseous marl, $\left(\frac{53}{100}\right)$ at e rate of two hundred and fifty bushels.

*Results.* 1819. In corn. No perceptible effect om the muscle-shells. The gypseous marling nsiderably better than on either side of it.

1820. Wheat—less difference.

1821. Grazed. Natural growth of white clover ickly set on the gypseous marling, much thinner the muscle-shells, and still less of it where no arl had been applied.

The whole field afterwards was put in wheat on summer fallow every second year, and grazed the intervening year—a course very unfavorable for observing, or permitting to take place, any effects of gypsum. Nothing more was noted of this experiment until 1825, when cattle were not turned in until the clover reached its full size. The strip covered with gypseous marl showed a remarkable superiority over the other marled piece, as well as the land which was still more calcareous by nature, and which had produced better in 1820. In several places, the white clover stood thickly a foot in height.

*Experiment* 18.

A strip of a quarter acre passing through rich black neutral loam, covered with gypseous marl at two hundred and fifty bushels.

*Results.* 1818. In corn. By July, the marled part seemed the best by fifty per cent., but afterwards the other land gained on it, and little or no difference was apparent, when the crop was matured.

1819. Wheat—no difference.

1820 and 1821. At rest. In the last summer the marled strip could again be easily traced, by the entire absence of sorrel, (which had been gradually increasing on this land since it had been secured from grazing,) and still more by its very luxuriant growth of bird-foot clover, which was thrice as good as that on the adjoining ground.

*Experiment* 19.

1822. On a body of neutral soil which had been reduced quite low, but was well manured in 1819 when last cultivated, gypseous marl was spread on nine acres, at the rate of three hundred bushels. This terminated on one side at a strip of muscle-shell marl ten yards wide—its rate not remembered, but it was certainly thicker in proportion to the calcareous earth contained, than the other, which I always avoided laying on heavily, for fear of causing injury by too much gypsum. The line of division between the two marls, was through a clay loam. The subsoil was a retentive clay, which caused the rain water to keep the land very wet through the winter, and early part of spring.

*Results.* 1822. In corn, followed by wheat in 1823: not particularly noticed—but the benefits must have been very inconsiderable. All the muscle-shell marling, and four acres of the gypseous, sowed in red clover, which stood well, but was severely checked, and much of it killed, by a drought in June, when the sheltering wheat was reaped. During the next winter (by neglect) my horses had frequent access to this piece, and by their trampling in its wet state, must have injured both land and clover. From these disasters the clover recovered surprisingly; and in 1824, two mowings were obtained, which though not heavy, were better than from any of my previous attempts to raise this grass. In 1825, the growth was still better, and yielded more to the scythe. This was the first time that I had seen clover worth mowing on the third year after sowing—and had never heard of its being comparable to the second year's growth any where in the lower country. The growth on the muscle-shell marling was very inferior to the

other, and was not mowed at all the last year, being thin and low, and almost eaten out by wire grass.

1826. In corn—and it was remarkable that the difference shown the last year was reversed, the muscle-shell marling now having much the best crop.

In these and other applications to neutral soils, I ascribe the earliest effects entirely to gypsum, as well as the peculiar benefit shown to clover, throughout. The later effects on grain, are due to the calcareous earth in the manure.

Another opinion was formed from the effects of gypseous marl, which may lead to profits much more important than any to be derived from the limited use of this, or any similar mineral compound—viz: *that gypsum may be profitably used after calcareous manures, on soils on which it was totally inefficient before.* I do not present this as an established fact, of universal application—for the results of some of my own experiments are directly in opposition. But however it may be opposed by some facts, the greater weight of evidence furnished by my experiments and observations, decidedly supports this opinion. If correct, its importance to our low country is inferior only to the value of calcareous manures—which value, may be almost doubled, if the land is thereby fitted to receive the wonderful benefits of gypsum and clover.

It is well known that gypsum has failed entirely as a manure on nearly all the land on which it has been tried in the tide-water district—and we may learn from various publications, that as little general success has been met with along the Atlantic coast, as far north as Long Island. To account for this general failure of a manure so efficacious elsewhere, some one offered a reason, which was received without examination, and which is still considered by many as sufficient, viz. that the influence of salt vapors destroyed the power of gypsum on and near the sea coast. But the same general worthlessness of that manure extends one hundred miles higher than the salt water of the rivers—and the lands where it is profitably used, are much more exposed to sea air. Such are the rich neutral soils of Curle's Neck, Shirley, Berkley, Brandon, and Sandy Point on James River, on all which gypsum on clover has been extensively and profitably used. On acid soils, I have never heard of enough benefit being obtained from gypsum to induce the cultivator to extend its use further than making a few small experiments. When any effect has been produced on an acid soil, (so far as instructed by my own experience, or the information of others,) it has been caused by applying to small spaces, comparatively large quantities—and even then, the effects were neither considerable, durable nor profitable. Such have been the results of many small experiments made on my own acid soils—and very rarely was the least perceptible effect produced. Yet on some of the same soils, after marling, the most evident benefits have been obtained from gypsum on clover. The soils on which the 1st and 10th experiments were made, (at some distance from the measurements,) had both been tried with gypsum, and at different rates of thickness, before marling, without the least effect. Several years after both had been marled, gypseous earth (from the bed described pp. 48, 49,) was spread at twenty bushels the acre, (which gave four bushels of pure gypsum,) on clover, and produced in some parts, a growth I have never seen surpassed. It is proper to state that such results have been produced only by heavy dressings. Mr. Thomas Cocke of Tarbay has this last spring (1831) sowed nearly four tons of Nova Scotia gypsum on clover on marled land, a continuation of the same ridge that my 1st, 2d, 3d, and 4th experiments were made on, and very similar soil. His dressing, at a bushel to the acre, before the summer had passed, produced evident benefit where it is absolutely certain that none could have been obtained before marling.

On soils naturally calcareous, I have in some experiments greatly promoted the growth of corn by gypsum, and have doubled the growth of clover on my best land of that kind. When the marl containing gypsum was applied, benefit from that ingredient was almost certain to be obtained.

All these facts, if presented alone, would seem to prove clearly the correctness of the opinion that the acidity of our soils caused the inefficacy of gypsum, and that the application of calcareous earth, which will remove the former, will also serve to bring the latter into useful operation. But this most desirable conclusion is opposed by the results of other experiments, which though fewer in number, are as strong as any of the facts that favor that conclusion. If the subject was properly investigated, those facts, apparently in opposition, might be explained so as no longer to contradict this opinion—perhaps even help to confirm it. Good reasons, deduced from established chemical truths, may be offered to explain why the acidity of our soils should prevent the operation of gypsum: but it may be deemed premature to attempt the explanation of any supposed fact before every doubt of its existence has been first removed. This subject well deserves a more full investigation from those who can be aided by more information, whether practical or scientific. [Appendix I.]

One of the circumstances will be mentioned which appears most strongly opposed to the opinion which has been advanced. On the poor acid clay soil, of such peculiar and base qualities which forms the subject of the 5th, 6th, and 7th experiments, gypsum has been sufficiently tried and has produced not the least benefit, either before marling, or afterwards. Yet the growth of clover on this land after marling, is fully equal to what might be expected from the best operation of gypsum. Now if it could be ascertained that a very small proportion of either *sulphuric acid*, or of the *sulphate of iron* exists in this soil, it would completely explain away this opposing fact, and make it the strongest support of my position. The sulphate of iron has sometimes been found in arable soil,* and sulphuric acid has been detected in certain clays.† I have seen, on the same farm, a clay of very similar appearance to this soil, which had once contained one of these substances, as was proved by the formation of crystallized sulphate of lime, where the clay came in contact with calcareous earth. The sulphate of lime was found in the small fissures of the clay, extending sometimes one or two feet distant from the calcareous earth below. Precisely the same chemic

*Ag. Chem. p. 141.

†Kirwan on Manures.

change would take place in a soil containing sulphuric acid, or sulphate of iron, as soon as marl was applied. The sulphuric acid, (whether free or combined with iron) would immediately unite with the lime presented, and form gypsum, (sulphate of lime.) Proportions of these substances too small perhaps to be detected by analysis, would be sufficient to form three or four bushels of gypsum to the acre—more than enough to produce the greatest effect on clover—and to prevent any benefit being derived from a subsequent application of gypsum.

Since the publication of the foregoing part of this chapter, in the first edition, my use of gypsum, on land formerly acid, has been more extended, and the results have been such as to give additional confidence in the practice, and, indeed, an assurance of good profit, on the average of such applications. But still, as before, disappointments either total or nearly so, in the effect of such applications, have sometimes occurred, and without there being any apparent cause to which to attribute such disappointment in the results.

In 1832, nine acres of the same body of ridge land above referred to, adjoining the piece on which the 1st, 2nd, 3rd and 4th experiments were made, and more lately cleared, were sowed in clover in the early part of 1831, on wheat. The next spring, French plaster was sowed at the rate of a bushel to the acre, except on four marked adjoining squares, each about one-third of an acre, one of which was left without plaster, and the others received it at the several rates of 2, 3, and 4 bushels to the acre. The whole brought a middling crop, and was mowed for hay, except the square left without gypsum, which did not produce more than half as much as the adjoining land where gypsum was applied at one bushel the acre. The product of the other pieces was slightly increased by each addition to the gypsum, but by no means in proportion to the increased quantity used: nor was the effect of the four bushels near equal to that formerly obtained, in several cases, from 20 bushels of gypseous earth taken from the river bank. Hence it seems, that it was not merely the unusual quantity of gypsum applied in this earth, which produced such remarkable benefit; and we must infer that it contains some other quality or ingredient capable of giving additional improvement to clover.

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## CHAPTER XV.

### THE DAMAGE CAUSED BY CALCAREOUS MANURE, AND ITS REMEDIES.

PROPOSITION 5. *Continued.*

The injury or disease in grain crops produced by marling has so lately been presented to our notice, that the collection and comparison of many additional facts will be required before its cause can be satisfactorily explained. But the facts already ascertained will show how to avoid the danger in future, and to find remedies for the evils already inflicted by the injudicious use of calcareous manures.

The earliest effect of this kind observed, was in May 1834, on the field containing experiment 10. The corn on the land marled four years before, sprang up and grew with all the vigor and luxuriance that was expected from the appearance of increased fertility exhibited by the soil, as before described, (page 44.) About the 20th of May the change commenced, and the worst symptoms of the disease were seen by the 11th of June. From having as deep a color as young corn shows on the richest soils, it became of a pale sickly green. The leaves, when closely examined, seemed almost transparent—afterwards were marked through their whole length by streaks of rusty red, separated very regularly by what was then more of yellow than green—and next they began to shrivel, and die downwards from their extremities. The growth of many of the plants was nearly stopped. Still some few showed no sign of injury, and maintained the vigorous growth which they began with, so as by contrast more strongly to mark the general loss sustained. The appearance of the field was such, that a stranger would have supposed that he saw the crop of a rich soil exposed to the worst ravages of some destructive kind of insect: but neither on the roots or stalks of the corn could any thing be found to support that opinion. Before the 1st of August, this gloomy prospect had improved. Most of the plants seemed to have been relieved of the infliction, and to grow again with renewed vigor. But before that time, many were dead, and it was impossible that the others could so fully recover as to produce any thing approaching a full crop for the land. It has been shown in the report of the products of Exp. 10, what diminution of crop was then sustained—and that the evil was not abated by the next cultivation. Still, neither of the diseased measured pieces has fallen as low as to its product before marling—nor do I think that such has been the result on any one acre on my farm, though many smaller spots have been rendered incapable of yielding a grain of corn or wheat.

The injury caused to wheat by marling is not so easy to describe, though abundantly evident to the observer. Its earliest growth, like that of corn, is not affected. About the time for heading, the plants most diseased appear as if they were scorched, and when ripe, will be found very deficient in grain. On very poor spots, from which nearly all the soil has been washed, sometimes fifty heads of wheat taken together would not furnish as many grains of wheat. This crop, however, suffers less than corn on the same land—perhaps because its growth is nearly completed by the time that the warm season begins, to which the ill effects of calcareous manures seem confined.

When these unpleasant discoveries were first made, two hundred and fifty acres had already been marled so heavily, that the same evil was to be expected to visit the whole. My labors thus bestowed for years had been greatly and unnecessarily increased—and the excess, worse than being thrown away, had served to take away that increase of crop, that lighter marling would have ensured. But though much and general injury was afterwards sustained from the previous work, yet it was lessened in extent and degree, and sometimes entirely avoided, by the remedial measures which were adopted. My observation and comparison of all the facts presented, led to the following conclusions, and pointed out the course

by which to avoid the recurrence of the evil, and the means to lessen or remove it, where it had already been inflicted.

1st. No injury has been sustained on any soil of my farm by marling not more heavily than two hundred and fifty heaped bushels to the acre, with marl of strength not exceeding $\frac{40}{100}$ of calcareous earth.

2d. Dressings twice as heavy seldom produce damage to the first crop on any soil—and never even on the after crops on any calcareous, or good neutral soil—nor on any acid soil supplied plentifully with vegetable matter.

3d. On acid soils marled too heavily, the injury is in proportion to the extent of one or all these circumstances of the soil—poverty, sandiness, and severe cropping and grazing, whether previously or subsequently.

4th. Clover, both red and white, will live and flourish on the spots most injured for grain crops, by marling too heavily. Thus, in the case before cited of land adjacent to the pieces measured in Exp. 10, and equally over-marled, very heavy red clover was raised in 1830, by adding gypsum, and which was succeeded by a good growth of corn, free from every mark of disease, in 1832.

5th. A good dressing of putrescent manure removes the disease completely, (see page 46.) All kinds of marl (or fossil shells) have sometimes been injurious—but such effects have been more generally experienced from the dry yellow marl, than from the blue and wet. It is possible that some unknown ingredient in the former may add to its hurtful power.

The inferences to be drawn from these facts are evident. They direct us to avoid injury, by applying marl lightly at first, and to be still more cautious according to the existence of the circumstances stated as increasing the tendency of marl to do harm. Next, if the over-dose has already been given, to forbid grazing entirely, and to furnish putrescent manure as far as possible—or to omit one or two grain crops, so as to allow more vegetable matter to be fixed in the land—to apply putrescent manures—and to sow clover as soon as circumstances permit. One or more of these remedies have been used on most of my too heavily marled land—and with considerable, though not always with entire success, because the means for the cure could not always be furnished at once in sufficient abundance. Other persons, who permitted close grazing, and adopted a more scourging rotation of crops, have suffered more damage, from lighter dessings of marl than mine.

But though the unlooked for damage sustained from this cause produced much loss and disappointment, and has greatly retarded the progress of my improvements, it did not stop my marling, nor abate my estimate of the value of the manure. If a cover of five hundred or six hundred bushels was so strong as to injure land of certain qualities, it seemed to be a fair deduction, that the benefit expected from so heavy a dressing, might have been obtained from half the quantity—if not on the first crop, at least on every one afterwards. *That* surely is nothing to be lamented. It also afforded some consolation for the evil of the too heavy marlings already applied, that the soil was thereby fitted to seize and retain a greater quantity of vegetable matter, and would thereby ultimately reach a higher degree of fertility.

The cause of this disease is less apparent than its remedies. It is certain that it is not produced merely by the quantity of calcareous earth in the soil. If it were so, similar effects would always be found on soils containing far greater proportions of that earth. Such effects are not known to any extent, except on soils formerly acid, and made calcareous artificially. The small spots of land that nature has made excessively calcareous and sandy (as the specimen 4, page 19,) produce a pale feeble growth of corn, such as might be expected from a poor gravel—but whether the plants yield grain, or are barren, they show none of those peculiar and strongly marked symptoms of disease which have been described.

By calculation, it appears that the heaviest dressing causing injurious consequences, mixed to the depth of five inches, has not given to the soil a proportion of calcareous earth equal to two per cent. This proportion is greatly exceeded in our best shelly land, and no such disease is found there, even when the rich mould is nearly all washed away, and the shells mostly left. Soils of remarkable fertility from the prairies of Alabama and Mississippi have been shown (page 22) to contain from 8 to 16 per cent. of calcareous earth, all of which proportions were in the state of most minute division, and therefore most ready to produce this disease, if it could have been produced by the quantity of this ingredient. Very fertile soils in France and England sometimes contain twenty or thirty per cent. of calcareous earth. Among the soils of remarkable good qualities analyzed by Davy, one is stated to contain about $\frac{28}{100}$, and another, which was eight-ninths of silicious sand, contained nearly $\frac{10}{100}$ of calcareous earth. Nor does he intimate that such proportions are very rare. Similar results have been stated, from analyses reported by Kirwan, Young, Bergman, and Rozier, (page 46,) and from all, the same deduction is inevitable, that much larger natural proportions of calcareous earth, than our diseased lands have received, are very common in France and England, without any such effect being produced.

From the numerous facts of which these are examples, it is certain that calcareous earth acting alone, or directly, has not caused this injury: and it seems most probable that the cause is some new combination of lime formed in acid soils only—and that this new combination is hurtful to grain under certain circumstances which we may avoid—and is highly beneficial to every kind of clover. Perhaps it is the *salt of lime*, formed by the calcareous manure with the acid of the soil, which not meeting with enough vegetable matter to combine with and fix in the soil, causes by its excess, all these injurious effects.

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## CHAPTER XVI.

### RECAPITULATION OF THE EFFECTS OF CALCAREOUS MANURES, AND DIRECTIONS FOR THEIR MOST PROFITABLE APPLICATION.

#### Proposition 5. *Continued.*

From the foregoing experiments may be gathered most of the effects, both injurious and

neficial, to be expected from calcareous ma-
ires, on the several kinds of soils here described. formation obtained from statements in detail of gricultural experiments, is far more satisfactory to e attentive and laborious inquirer, than a mere port of the general opinions of the experimenter, erived from the results. But however preferable ay be this mode of reporting facts, it is necessa-ly deficient in method, clearness, and concise-ess. It may therefore be useful to bring together e general results of these experiments in a some-hat digested form, to serve as rules for practice. ther effects of calcareous manures will also be ated, which are equally established by expe-ence, but which did not belong to any one accu-tely observed experiment.

The results that have been reported confirm in most every particular the chemical powers before tributed to calcareous manures, by the theory of eir action. It is admitted that causes and effects ere not always proportioned—and that some-mes trivial apparent contradictions were present-d. But this is inevitable, even with regard to e best established doctrines, and the most per-ct processes in agriculture. There are many ractices universally admitted to be beneficial—et there are none, which are not found sometimes seless, or hurtful, on account of some other at-endant circumstance, which was not expected, nd perhaps not discovered. Every application of alcareous earth to soil, is a chemical operation on great scale: decompositions and new combina-ons are produced, and in a manner generally con-orming to the operator's expectations. But other nd unknown agents may sometimes have a share the process, and thus cause unlooked for results. uch differences between practice and theory have ometimes occurred in my use of calcareous ma-ures (as may be observed in some of the report-d experiments) but they have neither been fre-uent, uniform, nor important.

Under like circumstances in other respects, the enefit derived from marling will be in proportion o the quantity of vegetable or other putrescent mat-er given to the soil. It is essential that the culti-ation should be mild, and that no grazing be per-nitted on poor lands. Wherever farm-yard manure s used, the land should be marled heavily, and if he marl is applied first so much the better. The ne manure cannot act by fixing the other, except o far as they are in contact, and both well mixed vith the soil.

On *galled* spots, from which all the soil has been vashed, and where no plant can live, the applica-ion of marl alone is utterly useless. Putrescent nanures alone would there have but little effect, nless in great quantity, and would soon be all ost. But marl and putrescent matter together erve to form a new soil, and thus both are brought nto useful action: the marl is made active, and he putrescent manure permanent. The only per-ect cures that I have been able to make, at one peration, of galls produced upon a barren subsoil, vere by applying a heavy dressing of both calca-eous and putrescent manures together: and this nethod may be relied on as certainly effectual. But though a fertile soil may thus be created, and ixed durably on galls otherwise irreclaimable, the ost will generally exceed the value of the land ecovered, from the great quantity of putrescent natter required. Much of our acid hilly land, has been deprived by washing of a considerable portion of its natural soil, though not yet made entirely barren. The foregoing remarks equally apply to this kind of land, to the extent that its soil has been carried off. It will be profitable to apply marl to such land—but its effect will be di-minished, in proportion to the previous removal of the soil. Calcareous soils are much less apt to wash than other kinds, from the difference of tex-ture. When a field that has been injured by washing is marled, within a few years after many of the old gulleys will begin to produce vegetation, and show a soil gradually forming from the dead vegetables brought there by winds and rains, al-though no means should have been used to aid this operation.

The effect of marling will be much lessened by the soil being kept under exhausting cultivation. Such were the circumstances under which we may suppose that marl was tried and abandoned many years ago, in the case referred to in page 37. Pro-ceeding upon the false supposition that marl was to enrich by direct action, it is most probable that it was applied to some of the poorest and most exhausted land, for the purpose of giving the ma-nure a "fair trial." The disappointment of such ill-founded expectations, was a sufficient reason for the experiment not being repeated, or being scarcely ever referred to again, except as evidence of the worthlessness of marl. Yet with proper views of the action of this manure, this experi-ment might at first, have as well proved the early efficacy and value of marl, as it now does its du-rability.

When acid soils are equally poor, the increase of the first crop from marling will be greater on sandy, than on clay soils; though the latter, by heavier dressings and longer time, may ultimately become the best land, at least for wheat and for grass. The more acid the growth of any soil is, or would be, if suffered to stand, the more increase of crop may be expected from marl; which is di-rectly the reverse of the effects of putrescent ma-nures. The increase of the first crop on worn acid soil, I have never known under fifty per cent., and more often is as much as one hundred—and the improvement continues to increase, under mild til-lage, to three or four times the original product of the land. [See Exp. 11, page 46, and Exp. 4 and 6.] In this, and other general statements of effects, I suppose the land to bear not more than two grain crops in four years, and not to be sub-jected to grazing—and that a sufficient cover of marl has been laid on for use, and not enough to cause disease. It is true, that it is difficult, if not impossible, to fix that proper medium, varying as it may on every change of soil, of situation, and of the kind of marl. But whatever error may be made in the proportion of marl applied, let it be on the side of light dressing, (except where pu-trescent manures are also laid on, or designed to be laid on before the next course of crops begins) —and if less increase of crop is gained to the acre, the cost and labor of marling will be lessened in a still greater proportion. If, after tillage has served to mix the marl well with the soil, sorrel should still show to any extent, it will sufficiently indicate that not enough marl had been applied, and that it may be added to, safely and profitably. If the nature of the soil, its condition and treatment, and the strength of the marl, all were known, it would

be easy to direct the amount of a suitable dressing: but without knowing these circumstances, it will be safest to give two hundred and fifty, or three hundred bushels to the acre of worn acid soils, and at least twice as much to newly cleared, or well manured land. Besides avoiding danger, it is more profitable to marl lightly at first on weak lands. If a farmer can carry out only ten thousand bushels of marl in a year, he will derive more product, and confer a greater amount of improvement, by spreading it over forty acres of the land intended for his next crop, than on twenty: though the increase to the acre, would probably be greatest in the latter case. By the lighter dressing, the land of the whole farm will be marled, and be storing up vegetable matter for its progressive improvement, in half the time that it could be marled at double the rate.

The greater part of the calcareous earth applied at one time cannot begin to act as manure before several years have passed, owing to the coarse state of many of the shells, and the want of thoroughly mixing them with the soil. Therefore, if enough marl is applied to obtain its full effect on the first course of crops, there will certainly be too much afterwards.

Perhaps the greatest profit to be derived from marling, though not the most apparent, is on such soils as are full of wasting vegetable matter. Here the effect is mostly preservative, and the benefit and profit may be great, even though the increase of crop may be very inconsiderable. Putrescent manure laid on any acid soil, or the natural vegetable cover of those newly cleared, without marl, would soon be lost, and the crops reduced to one-half, or less. But when marl is previously applied, this waste of fertility is prevented; and the estimate of benefit should not only include the actual increase of crop caused by marling, but as much more as the amount of the diminution, which would otherwise have followed. Every intended clearing of woodland, and especially of that under a second growth of pines, ought to be marled before cutting down—and it will be still better, if it can be done several years before. If the application is delayed until the new land is brought under cultivation, though much putrescent matter will be saved, still more must be wasted. By using marl some years before obtaining a crop from it, as many more successive growths of leaves will be converted to useful manure, and fixed in the soil—and the increased fertility will more than compensate for the delay. By such an operation, we make a loan to the soil, with a distant time for payment, but on ample security, and at a high rate of compound interest.

Some experienced cultivators have believed that the most profitable way to manage pine old fields, when cleared of their second growth, was to cultivate them every year, until worn out—because, as they said, such land would not last much longer, no matter how mildly treated. This opinion, which seems so absurd, and in opposition to all the received rules for good husbandry, is considerably supported by the properties which are here ascribed to such soils. When these lands are first cut down, an immense quantity of vegetable matter is accumulated on the surface—which, notwithstanding its accompanying acid quality, is capable of making two or three crops nearly or quite as good as the land was ever able to bring. But as the soil has no power to retain this vegetable matter, it will begin rapidly to decompose and waste, as soon as exposed to the sun, and will be lost, except so much as is caught while escaping, by the roots of growing crops. The previous application of marl, would make it profitable in these, as well as other cases, to adopt a mild and meliorating course of tillage.

Less improvement will be obtained by marling worn soils of the kind called "free light land," than other acid soils which originally produced much more sparingly. The early productiveness of this kind of soil, and its rapid exhaustion by cultivation, at first view seem to contradict the opinion, that durability and the ease of improving by putrescent manures are proportioned to the natural fertility of the soil. But a full consideration of circumstances will show that no such contradiction exists.

In defining the term *natural fertility*, it was stated that it should not be measured by the earliest products of a new soil, which might be either much reduced, or increased, by temporary causes. The early fertility of free light land is so rapidly destroyed, as to take away all ground for considering it as fixed in, and belonging to the soil. It is like the effect of dung on the same land afterwards, which throws out all its effect in the course of one or two years, and leaves the land as poor as before. But still it needs explanation why so much productiveness can at first be exerted by any acid soil, as in those described in the 14th experiment. The cause may be found in the following reasons. These soils, and also their subsoils, are principally composed of coarse sand, which makes them of more open texture than best suits pine, and (when rich enough) more favorable to other trees, the leaves of which have no natural acid, and therefore decompose more readily. As fast as the fallen leaves rot, they are of course exposed to waste—but the rains convey much of their finer parts down into the open soil, where the less degree of heat retards their final decomposition. Still this enriching matter is liable to be further decomposed, and to final waste: but though continually wasting, it is also continually added to by the rotting leaves above. The shelter of the upper coat of unrotted leaves, and the shade of the trees, cause the first, as well as the last stages of decomposition, to proceed slowly, and to favor the mechanical process of the products being mixed with the soil. But there is no chemical union of the vegetable matter with the soil. When the land is cleared, and opened by the plough, the decomposition of all the accumulated vegetable matter is hastened by the increased action of sun and air, and in a short time converts every thing into food for plants. This abundant supply suffices to produce two or three fine crops. But now, the most fruitful source of vegetable matter has been cut off—and the soil is kept so heated (by its open texture) as to be unable to hold enriching matters, even if they were furnished. The land soon becomes poor, and must remain so, as long as these causes operate, even though cultivated under the mildest rotation. When the transient fertility of such a soil is gone, its acid qualities (which were before concealed in some measure by so much enriching matter,) become evident. Sorrel and broom grass cover the land—and if allowed to stand, pines will

ke complete possession, because the poverty of e soil leaves them no rival to contend with.

Marling deepens cultivated sandy soils, even wer than the plough may have penetrated. This as an unexpected result, and when first observed, emed scarcely credible. But this effect also is a nsequence of the power of calcareous earth to x manures. As stated in the foregoing paraaph, the soluble and finely divided particles of tted vegetable matters are carried by the rains low the soil: but as there is no calcareous earth ere to fix them, they must again rise in a gases form, after their last decomposition, unless preiously taken up by growing plants. But after e soil is marled, calcareous as well as putrescent atter is carried down by the rains as far as the il is open enough for them to pass. This will ways be as deep as the ploughing has been, and loose earth, somewhat deeper—and the chemial union formed between these different subances, serves to fix both, and thus increases the epth of the soil. This effect is very different om the deepening of a soil by letting the plough in into the barren subsoil. If by this mechanil process, a soil of only three inches is increased five, as much as it gains in depth, it loses in chness. But when a marled soil is deepened radually, its dark color and apparent richness is creased, as well as its depth. Formerly singleorse ploughs were used to break all my acid soils, nd even they would often turn up subsoil. The verage depth of soil on old land did not exceed ree inches, nor two on the newly cleared. Even efore marling was commenced, my ploughing ad generally sunk into the subsoil—and since 825, most of this originally thin soil has required ree mules, or two good horses to a plough, to reak the necessary depth. The soil is now from ve to seven inches deep generally, from the joint peration of marling and deepening the ploughing little in the beginning of every course of crops.

How destructive to the power of soil this depth f ploughing would have been, without marling, ay be inferred from the continued decrease of he crop, through four successive courses of a very ild rotation, on the spot kept without marl in experiment 10. Yet the depth of ploughing there did ot exceed six inches, and depths of nine and even welve inches were tried, without injury, on parts f the adjacent marled land.

Besides the general benefit which marling auses equally to all crops, by making the soils hey grow on richer and more productive, there re other particular benefits which affect some lants more than others. For example, marling erves to make soils warmer, and thereby hastens he ripening of every crop, more than would take lace on the like soils, if made equally producive by other than calcareous manures. This uality of marled land is highly important to coton, as our summers are not long enough to maure the later pods. Wheat also derives especial enefit from the warmth thus added to the soil: it s enabled better to withstand the severe cold of vinter; and even the short time by which its ipening is forwarded by marling, serves very nuch to lessen the danger of the crop from *rust*. Wheat also profits by the absorbent power of marled land, (by which sands acquire, to some exent, the best qualities of clays,) though less so han clover and other grasses that flourish best in a moist climate. Indian corn does not need more time for maturing than our summers afford (except on the poorest land,) and can sustain much drought without injury; and therefore is less aided by these qualities of marled land. Most (if not all) the different plants of the pea kind, and all the varieties of clover, derive such remarkable benefit from marling, that it must be caused by some peculiarity in the nature of those plants. Perhaps a large portion of calcareous earth is necessary as part of their food, to aid in the formation of the substance of plants, as well as to preserve their healthy existence.

On acid soils without manure it is scarcely possible to raise red clover—and even with every aid from putrescent manure, the crop will be both uncertain and unprofitable. The recommendation of this grass as part of a general system of cultivation and improvement, by the author of *Arator*, is sufficient to prove that his improvements were made on soils far better than such as are general. Almost every zealous cultivator and improver (in prospect) of acid soil has been induced to attempt clover culture, either by the recommendations of writers on this grass, or by the success witnessed on better constituted soils elsewhere. The utmost that has been gained by any of these numerous efforts, has been sometimes to obtain one, or at most two mowings, of middling clover, on some very rich lot, which had been prepared in the most perfect manner by the previous cultivation of tobacco. Even in such situations, this degree of success could only be obtained by the concurrence of the most favorable seasons. Severe cold, and sudden alternations of temperature in winter and spring, and the spells of hot and dry weather which we usually have in summer, were alike fatal to the growth of clover, on so unfriendly a soil. The few examples of partial success never served to pay for the more frequent failures and losses; and a few years' trial would convince the most ardent, or the most obstinate advocate for the clover husbandry, that its introduction on the great body of land in Lower Virginia, was absolutely impossible. Still the general failure was by common consent attributed to any thing but the true cause. There was always some reason offered for each particular failure, sufficient to produce it, and but for which, (it was supposed) a crop might have been raised Either the young plants were killed by freezing soon after first springing from the seed—or a drought occurred when the crop was most exposed to the sun, by reaping the sheltering crop of wheat—or native and hardy weeds overran the crop—and all such disasters were supposed to be increased in force, and rendered generally fatal, by our sandy soil, and hot and dry summers. But after the true evil, *the acid nature of the soil*, is removed by marling, clover ceases to be a feeble exotic. It is at once naturalized on our soil, and is able to contend with rival plants, and to undergo every severity and change of season, as safely as our crops of corn and wheat—and offers to our acceptance the fruition of those hopes of profit and improvement from clover, with which heretofore we have only been deluded.

After much waste of seed and labor, and years of disappointed efforts, I abandoned clover as utterly hopeless. But after marling the fields on which the raising of clover had been vainly attempted, there arose from its scattered and feeble

remains, a growth which served to prove that its cultivation would then be safe and profitable. It has since been gradually extended nearly over all the fields. It will stand well, and maintain a healthy growth on the poorest marled land: but the crop is too scanty for mowing, or perhaps for profit of any kind, on most sandy soils, unless aided by gypsum. Newly cleared lands yield better clover than the old, though the latter may produce as heavy grain crops. The remarkable crops of clover raised on very poor clay soils, after marling, have been already described. This grass, even without gypsum, and still more if aided by that manure may add greatly to the improving power of marl: but it will do more harm than service, if we greedily take from the soil too large a share of the supply of putrescent matter which it affords.

Some other plants less welcome than clover, are equally favored by marling. Greensward, blue grass, wire grass, and partridge pea, will soon increase so as to be not less impediments to tillage, than evidences of an entire change in the character and power of the soil.

If the foregoing views may be confided in, the general course most proper to pursue in using calcareous manures may thence be deduced without difficulty. But as I have found, since the publication of the first edition of this essay, that many persons still ask for more special directions to guide their operations, and as all such difficulties may not be entirely obviated even by the more full details now given, I will here add the following directions, at the risk of their being considered superfluous. These directions, like all the foregoing reasoning, may apply generally, if not entirely, to the use of all kinds of calcareous manures, and to soils in various regions: but to avoid too wide a range, I shall consider them as applied particularly to the poor lands, and to the fossil shells, or marl, of the tide-water region, and addressed to persons who are just commencing their improvements.

As the cheapest mode of furnishing vegetable matter to land intended to be marled and cultivated, no grazing should be permitted. It is best to put the marl on the grass previous to ploughing the field for corn, as the early effect of this manure is greatest when it has been placed in contact with the vegetable matter. But this advantage is not so great as to induce the ploughing to be delayed, or to stop the marling after that operation. When the marl is spread upon the ploughed surface, it can be better mixed with the soil by the cultivation of the crop—and this advantage in some measure compensates for the loss of that which would have been obtained from an earlier application on the sod. If marl is ploughed in, it should not be so deeply as to prevent its being mixed with the soil, speedily and thoroughly, by the subsequent tillage. To make sure of equal distribution, the marl should be spread regularly over the surface. From neglect in this respect, a dressing of marl is often too thin in many places to have its proper effect, and in others, so thick as to prove injurious. Hence it is, that marl-burnt stalks of corn, and tufts of sorrel are sometimes seen on the same acre.

After the first year, the farmer may generally marl fast enough to keep ahead of his cultivation: and even though he should reduce the space of his tillage to one-half, it will be best for him not to put an acre in corn without its being marled. Fifty acres can generally be both marled and tilled, as cheaply as one hundred can be tilled without marling; and the fifty will produce as much as the hundred, in the first course of crops, and much more afterwards.

That rotation of crops which gives most vegetable matter to the soil, is best to aid the effect of marl recently applied. The four-shift rotation is convenient in this respect, because two or three years of rest may be given in each course of the rotation at first, upon the poorest land; and the number of exhausting crops may be increased, first to two, then to three in the rotation, as the soil advances to its highest state of productiveness.

After marling, clover should be sown, and gypsum on the clover. On poor, though marled land, of course only a poor growth of clover can be expected: but wherever other manures are given, and especially if gypsum is found to act well, the crop of clover becomes a most important part of the improvement by marling. Without clover, and without returning the greater part of its product to the soil, the great value of marling will not be seen. A small proportion of the clover may be used as food for cattle—and in a few years this small share will far exceed all the grass that the fields furnished before marling, and the limitation of grazing. What is at first considered as lessening the food of grazing stock, and their products, within a few years becomes the source of a far more abundant supply.

During the first few years of marling, but little attention can (or ought to) be given to making putrescent manures, because the soil much more needs calcareous manure—and three acres may generally be supplied with the latter, as cheaply as one with the former. But putrescent manures cannot any where be used to so much advantage, as upon poor soils made calcareous: and no farmer can make and apply vegetable matter as manure to greater profit than he who has marled his poor fields, and can then withdraw his labor from applying the more to the less profitable manure. After the farm has been marled over at the light rate recommended at first, every effort should be made to accumulate and apply vegetable manures—and with their gradual extension over the fields, a second application of marl may be made, making the whole quantity in both the first and second marling 500 or 600 bushels to the acre, or even more, which would have been hurtful if given at first, but which will now be not only harmless, but necessary to fix and retain so much putrescent and nutritive matter in the soil.

If the course here advised is pursued on poor and acid soils, the products will be generally doubled in the first course of the rotation—often in the first crop immediately following the marling: and the original product may be expected to be tripled by the third return of the rotation. This will be from merely applying marl in sufficient (and not excessive) quantities, and giving the land two years rest in four, without grazing. But with the aid of farm-yard and other putrescent manures, and of clover, both of which should be largely in use during the second course of crops, still greater returns may be obtained.

When such statements as these are made, the question naturally occurs to the reader, "Has the writer himself met with so much success, and what has been the actual result of his labors in general,

ı the business so strongly recommended?" This uestion I have no right to shrink from, although ıe answer to be given fully, will be objectionable, om the egotism inseparable from such details, vhich are certainly not worth being thus presented ı public notice, and which are called for only beause silence on this head might be considered as perating against the general tenor of this essay. It vill be sufficient here to state generally, that my verage profits from marling, and the increased ertility derived from it, have not been as great as re promised above, nor such as might be expected om the most successful experiments of which the esults have been reported—and for these reasons. st. The greater part of my land was not of soil ıe best adapted to be improved by marling. 2nd. Iaving every thing to learn, and to prove by trial, nuch of my labor was lost uselessly, or spent in xcessive and injurious applications. 3d. The tness given to the soil by marl to produce clover vas not known until long after that auxiliary to nprovement ought to have been in full use. 4th. 'rom the want of labor and capital to use both alcareous and putrescent manures, the collecting nd applying of the latter were almost entirely eglected as long as there was full employment ı marling. And 5th. That general bad practical ıanagement, which I have to admit has marked ll my business, has of course also affected injuiously this important branch—though in a less egree, because it was as much as possible under ıy personal and close attention. With all these rawbacks to complete success, I am able to state ıe following general results of my operations. )mitting the land on Coggin's Point farm not suseptible of any considerable or profitable improveıent from marling, the great body of the farm, ıas been tripled in productive power since 1818, vhen my first experiment was made. Particular odies of soil now produce fourfold the former mount without any other kind of manure: and he whole farm including the parts least improved s well as the most, and allowing for the increase f extent, will now make more than double of its est product before marling.

With all the increase of products that I have scribed to marling, the heaviest crops stated may ppear inconsiderable to farmers who till soils more avored by nature. Corn yielding twenty-five or hirty bushels to the acre, is doubled by many natıral soils in the western states; and ten or twelve ushels of wheat, will still less compare with the roduct of the best limestone clay land. The culivators of our poor region, however, know that uch products, without any future increase, would e a prodigious addition to their present gains. Still it is doubtful whether these rewards are suffiiently high to tempt many of my countrymen peedily to accept them. The opinions of many armers have been so long fixed, and their habits re so uniform and unvarying, that it is difficult to xcite them to adopt any new plan of improveıent, except by promises of profits so great, that ın uncommon share of credulity would be necesary to expect their fulfilment. The net profits of narling, if estimated at twenty or even fifty per ent. per annum, on the expense, forever—or the ssurance by good evidence, of doubling the crops of a farm in ten years or less—will scarcely attract the attention of those who would embrace without any scrutiny, a plan that promised five times as much. Hall's scheme for cultivating corn was a stimulus exactly suited to their lethargic state: and that impudent Irish impostor found many steady old-fashioned farmers willing to pay for his directions for making five hundred barrels of corn, with only the hand labor of two men.

The products and profits derived from the use of marl as presented in the preceding pages, considerable as they are, have been kept down, or lessened in amount, by my then want of experience, and ignorance of the danger of injudicious applications. My errors may at least enable others to avoid similar losses, and thereby to reach equal profits with half the expense of time and labor. But are we to consider even the greatest increase of product that has been yet gained in a few years after marling, as showing the full amount of improvement and profit to be derived? I think not: and if we may venture to leave the sure ground of practical experience, and look forward to what is promised by the theory of the operation of calcareous manures, we must anticipate future crops far exceeding what have yet been obtained. To this, the ready objection may be opposed, that the sandiness of the greater part of our lands will always prevent their being raised to a high state of productiveness—and particularly, that no care, nor improvement can make heavy crops of wheat on such soils. This very general opinion is far from being correct—and as the error is important, it may be useful to offer some evidence in support of the great value to which sandy soils may arrive.

We are so accustomed to find sandy soils poor, that it is difficult for us to connect with them the idea of fertility, and still less of durability. Yet British agriculturists, who were acquainted with clays and clay loams, of as great value, and as well managed under tillage, as any in the world, speak in still higher terms of certain soils, which are even more sandy than most of ours. For example—"Rich sandy soils, however," says Sir John Sinclair, "such as those of Frodsham in Cheshire, are invaluable. They are cultivated at a moderate expense; and at all times have a dry soundness, accompanied by moisture, which secures excellent crops, even in the dryest summers."* Robert Brown, (one of the very few who has deserved the character of being both an able writer, and a successful practical cultivator,) says—"Perhaps a true sandy loam incumbent on a sound subsoil, is the most valuable of all soils."† Young, when describing the soils of France, in his agricultural survey of that country, in several places speaks in the highest terms of different bodies of light or sandy soils, of which the following example, of the extensive district which he calls the plain of the Garonne, will be enough to quote: "It is entered about Creisensac, and improves all the way to Montauban and Toulouse, where it is one of the finest bodies of fertile soil that can any where be seen:"——"Through all this plain, wherever the soil is found excellent, it consists usually of a deep mellow friable sandy loam, with moisture sufficient for any thing; much of it is calcareous."‡ The soil of Belgium so cele-

* Code of Agriculture, p. 12.

† Brown's Treatise on Agriculture, p. 218, of "Agriculture" in Edin. Ency.

‡ Young's Tour in France.

brated for its high improvement and remarkable productiveness, is mostly sandy. The author last quoted, in another work describes a body of land in the county of Norfolk, as "one of the finest tracts that is any where to be seen"——"a fine, " deep, mellow, putrid sandy loam, adhesive enough " to fear no drought, and friable enough to strain " off superfluous moisture, so that all seasons suit " it: from texture free to work, and from chemical " qualities sure to produce in luxuriance whatever " the industry of man commits to its friendly bo- " som."* Mr. Coke, the great Norfolk farmer, made on the average 24 bushels of wheat to the acre, on an estate of as sandy soil as our Southampton, (where probably a general average of two bushels could not be obtained, if general wheat culture was attempted)—and many other farms in Norfolk yielded much better wheat than Mr. Coke's in 1804, when Young's survey was made. Several farms averaged 36 bushels, and one of 40 is stated: and the general average of the county was 24 bushels.† Yet the county of Norfolk was formerly pronounced by Charles II. to be only fit " to cut up into strips, to make roads of for the balance of the kingdom"—and that sportive description expressed strongly the sandy nature of the soil, as well as its then state of poverty.

Because certain qualities of poor clay soils (particularly their absorbent power) make them better than poor sands for producing wheat, we most strangely attach a value to the stiffness and intractability of the former. Yet if all the absorbent quality and productive power of clay could be given to sand, surely the latter would be the more valuable in proportion to its being friable and easy to cultivate. The causes of all the valuable qualities and productive power of the rich sands that have been referred to, are only calcareous and putrescent manures, and depth of soil: and if the same means can be used, our sands may also be made as productive and valuable. I do not mean to assert that the most highly improved sandy soil can produce as much wheat as the best clay soils; but they will not fall so far short as to prevent their being the most valuable land, for wheat as well as other crops, on account of their being so easily cultivated, and less liable to suffer from bad seasons, or bad management. [Appendix K.]

## CHAPTER XVII.

### THE PERMANENCY OF CALCAREOUS MANURES.

PROPOSITION 5. *Continued.*

It was stated, (page 36) that the ground on which an old experiment was made and abandoned as a failure, more than fifty years ago, still continues to show the effects of marl. Lord Kames mentions a fact of the continued beneficial effect of an application of calcareous manure, which was known to be one hundred and twenty years old.‡ Every author who has treated of manures of this nature, attests their long duration: but when they sa that they will last twenty years, or even one hun dred and twenty years, it amounts to the admis sion that at some future time the effects of thes manures will be lost. This I deny—and from th nature and action of calcareous earth, claim fo its effects a duration that will have no end.

If calcareous earth applied as manure is not af terwards combined with some acid in the soil, i must retain its first form, which is as indestructi ble, and as little liable to be wasted by any caus whatever, as the sand and clay that form the othe earthy ingredients of the soil. The only possibl vent for its loss, is the very small proportion take up by the roots of plants, which is so inconsidera ble as scarcely to deserve naming.

Clay is a manure for sandy soils, serving to clos their too open texture. When so applied, no on can doubt but that this effect of the clay will las as long as its presence. Neither can calcareou earth cease to exert its peculiar powers as a ma nure, any more than clay can, by the lapse of tim lose its power of making sands more firm and ad hesive. Making due allowance for the minut quantity drawn up into growing plants, it is as ab surd to assert that the calcareous earth in a soi whether furnished by nature or not, can be ex hausted, as that cultivation can deprive a soil o its sand or clay.

But on my supposition that calcareous eart will change its form by combining with acid i the soil, it may perhaps be doubted whether it i equally safe from waste under its new form. I must be admitted, that the permanency of thi compound cannot be proved by its insolubility, o other properties, because neither the kind nor th nature of the salt itself is yet known.* But judgin from the force with which good neutral soils re sist the exhaustion of their fertility, and their al ways preserving their peculiar character, it can not be believed that the calcareous earth onc present, was lessened in durability by its chemica change of form. It has been contended that th action of calcareous earth is absolutely necessar to make a poor acid soil fertile: but it does no thence follow that other substances, and particu larly this salt of lime, may not serve as well t preserve the fertility bestowed by calcareou earth. All that is required for this purpose, is th power of combining with putrescent matter, an thereby fixing it in the soil: and judging solel from effects, this power seems to be possessed i an eminent degree by this new combination o lime. If this salt is the oxalate of lime, (as ther is most reason to believe,) it is insoluble in wate and consequently safe from waste—and the sam property belongs to most other combinations o lime with vegetable acid. The acetate of lime i soluble in water, and while alone, might be car ried off by rains. But if it combines with putres cent matter, by chemical affinity, its previous solu bility will no longer remain. Copperas is easil soluble: but when it forms one of the componen parts of ink, it can no longer be separately dis

*Young's Survey of Norfolk, p. 4.

†Young's Survey of Norfolk, p. 300 to 304.

‡Gentleman Farmer, page 266, 2d Edin. Ed.

*This passage is left as it stood in the first editio before the discovery of the humic acid was know Indeed no aid has been derived from that discover nor any change of language made in consequence o it, except by inserting the quotation respecting th substance, and the remarks thereon, at page 28.

solved by water, or taken away from the coloring matter combined with it. In rich limestone soils, and some of our best river lands, in which no calcareous earth remains, we may suppose that its change of form took place centuries ago. Yet however scourged and exhausted by cultivation, they still show as strongly as ever, those qualities which were derived from their former calcareous ingredient. When the dark color of such soils, their power of absorption, and of holding manures, their friability, and their peculiar fitness for clover and certain other plants, are no longer to be distinguished, then, and not before, may the salt of lime be considered as lost to the soil.

If we keep in mind the mode by which calcareous manure acts, its effects may be anticipated for a much longer time than my experience extends. Let us trace the supposed effects, from the causes, on an acid soil kept under meliorating culture. As soon as applied, the calcareous earth combines with all the acid then present, and to that extent, is changed to the vegetable salt of lime. The remaining calcareous earth continues to take up the after formations of acid, and (together with the salt so produced,) to fix putrescent manures, as fast as these substances are presented, until all the lime has been combined with acid, and all their product combined with putrescent matter. Both those actions then cease. During all the time necessary for those changes, the soil has been regularly increasing in productiveness; and it may be supposed that before their completion, the product had risen from ten to thirty bushels of corn to the acre. The soil has then become neutral. It can never lose its ability (under the mild rotation supposed,) of producing thirty bushels—but it has no power to rise above that product. Vegetable food continues to form, but is mostly wasted, because the salt of lime is already combined with as much as it can act on; and whatever excess of vegetable matter remains on the soil, is kept useless by acid also newly formed, and left free and noxious, as before the application of calcareous earth. But though this excess of acid may balance and keep useless the excess of vegetable matter, it cannot affect the previously fixed fertility, nor lessen the power of the soil to yield its then maximum product of thirty bushels. In this state of things, sorrel may again begin to grow, and its return may be taken as notice that a new marling is needed, and will afford additional profit, in the same manner as before, by destroying the last formed acid, and fixing the last supply of vegetable matter. Thus perhaps five or ten bushels more may be added to the previous product, and a power given to the soil gradually to increase as much more, before it will stop again for similar reasons, at a second maximum product of forty or fifty bushels. I pretend not to fix the time necessary for the completion of one or more of these gradual changes: but as the termination of each, and the consequent additional marling, will add new profits, it ought to be desired by the farmer, instead of his wishing that his first labor of marling each acre, may also be the last required. Every permanent addition of five bushels of corn to the previous average crop, will more than repay the heaviest expenses that have yet been encountered in marling. But whether a second application of marl is made or not, I cannot imagine such a consequence as the actual decrease of the product once obtained. My earliest marled land has been severely cropped, compared to the rotation supposed above, and yet has continued to improve, though at a slow rate. The part first marled in 1818, has since had only four years of rest in fifteen; and has yielded nine crops of grain, one of cotton, and one year clover twice mowed. This piece, however, besides being sown with gypsum, (with little benefit,) once received a light cover of rotted corn-stalk manure. The balance of the same piece of land (Exp. 1.) was marled for the crop of 1821—has borne the same treatment since, and has had no other manure, except gypsum once, (in 1830,) which acted well. These periods of twelve and fifteen years, are very short to serve as grounds to decide on the eternal duration of a manure. But it can scarcely be believed that the effect of any temporary manure, would not have been somewhat abated by such a course of severe tillage. Under milder treatment, there can be no doubt but there would have been much greater improvement.

If subjected to a long course of the most severe cultivation, a soil could not be deprived of its calcareous ingredient, whether natural or artificial: but though still calcareous, it would be in the end, reduced to barrenness, by the exhaustion of its vegetable matter. Under the usual system of exhausting cultivation, marl certainly improves the product of acid soils, and may continue to add to the previous amount of crop, for a considerable time: yet the theory of its action instructs us, that the ultimate result of marling under such circumstances, must be the more complete destruction of the land, by enabling it to yield all its vegetable food to growing plants, which would have been prevented by the continuance of its former acid state. An acid soil yielding only five bushels of corn may contain enough food for plants to bring fifteen bushels—and its production will be raised to that mark, as soon as marling sets free its dormant powers. But a calcareous soil reduced to a product of five bushels, can furnish food for no more, and nothing but an expensive application of putrescent manures, can render it worth the labor of cultivation. Thus it is, that soils, the improvement of which is most hopeless without calcareous manures, will be the most certainly improved with profit by their use.

## CHAPTER XVIII.

### THE EXPENSE AND PROFIT OF MARLING.

PROPOSITION 5. *Concluded.*

At this time there are but few persons among us who doubt the great benefit to be derived from the use of marl: and many of those who ten years ago deemed the practice the result of folly, and a fit subject for ridicule, now give that manure credit for virtues which it certainly does not possess; and from their manner of applying it, seem to believe it a universal cure for sterility. Such erroneous views have been a principal cause of the many injudicious and even injurious applications of marl. It is as necessary to moderate the ill-founded expectations which many entertain, as to excite the too feeble hopes of others.

The improvement caused by marling, and its per-

manency, have been established beyond question. Still the improvement may be paid for too dearly —and the propriety of the practice must depend entirely on the amount of its clear profits, ascertained by fair estimates of the expenses incurred.

With those who attempt any calculations of this kind, it is very common to set out on the mistaken ground that the expense of marling should bear some proportion to the selling price of the land: and without in the least underrating the effects of marl, they conclude that the improvement cannot justify an expense of six dollars on an acre of land that would not previously sell for four dollars. Such a conclusion would be correct if the land was held as an article for sale, and intended to be disposed of as soon as possible: as the expense in that case might not be returned in immediate profit, and certainly would not be added to the price of the land by the purchaser, under present circumstances. But if the land is held as a possession of any permanency, its previous price, or its subsequent valuation, has no bearing whatever on the amount which it may be profitable to expend for its improvement. Land that sells at four dollars, is often too dear at as many cents, because its product will not pay the expense of cultivation. But if by laying out for the improvement ten dollars, or even one hundred dollars to the acre, the average increased annual profit would certainly and permanently be worth ten per cent. on that cost of improvement, then the expenditure would be highly expedient and profitable. We are so generally influenced by a rage for extending our domain, that another farm is often bought, stocked and cultivated, when a liberal estimate of its expected products, would not show an annual clear profit of three per cent.: and any one would mortgage his estate to buy another thousand acres, that was supposed fully capable of yielding ten per cent. on its price. Yet the advantage would be precisely the same, if the principal money was used to enrich the land already in possession, (without regard to its extent, or previous value,) with equal assurance of its yielding the same amount of profit.

Nothing is more general, or has had a worse influence on the state of agriculture, than the desire to extend our cultivation, and landed possessions. One of the consequences of this disposition, has been to give an artificial value to the poorest land, considered merely as so much territory, while various causes have concurred to depress the price of all good soils much below their real worth. Whatever a farm will sell for, fixes its value as merchandise; but by no means is it a fair measure of its value as permanent farming capital.

The true value of land, and also of any permanent improvements to land, I would estimate in the following manner. Ascertain as nearly as possible the average clear and permanent income, and the land is worth as much money as would securely yield that amount of income, in the form of interest—which may be considered as worth 6 per cent. For example, if a field brings ten dollars average value of crops to the acre, in every course of a four-shift rotation, and the average expense of every kind necessary to carry on the cultivation, is also ten dollars—then the land yields nothing, and is worth nothing. If the average clear profit was two dollars and forty cents in the term, or only sixty cents a year, it would raise the value of the land to ten dollars—and if six dollars could be made annually, clear of all expense, it is equally certain that one hundred dollars would be the fair value of the acre. Yet if lands of precisely these rates of profit were offered for sale at this time, the poorest would probably sell for two dollars, and the richest for less than thirty dollars. In like manner, if any field that paid the expense of cultivation before, has its average annual net product increased six dollars for each acre, by some permanent improvement, the value thereby added to the field is one hundred dollars the acre, without regard to its former worth. Let the cost and value of marling be compared by this rule, and it will be found that the capital laid out in that mode of improvement will seldom return an annual interest of less than twenty per cent.—that it will more often equal forty—and sometimes reach even one hundred per cent. of annual and permanent interest on the investment. The application of this rule for the valuation of such improvements, will raise them to such an amount, that the magnitude of the sum may be deemed a sufficient contradiction of my estimates. But before this mode of estimating values is rejected, merely on the supposed absurdity of an acid soil being considered as raised from one dollar to thirty dollars per acre, by a single marling, let it at least be examined, and its fallacy exposed.

I admit the practical difficulty of applying this rule, however certain may be its theoretical truth. It is not possible to fix on the precise clear profit of any farm to its owner and cultivator; and any error made in these premises, is increased sixteen fold in the estimate of value founded on them. Still we may approximate the truth with most certainty by using this guide. The early increase of crop from marling, will in most cases be an equal increase of clear profit, (for the subsequent improvement and the additional offal will surely pay for the increase of labor—) and it is not very difficult to fix a value for that actual increase of crop, and thereby to estimate the capital value of the improvement.

This mode of valuing land, under a different form, is universally received as correct in England. Cultivation there is carried on almost entirely by tenants: and the annual rent which any farm brings on a long lease, fixes beyond question what is its annual clear profit to the owner. The price, or value of land, is generally estimated at so many "years' purchase," which means as many years' rent as will return the purchaser's money. There, the interest of money being low, increases the value of land according to this mode of estimation; and it is generally sold as high as twenty years' purchase. My estimate is less favorable for raising the value of our lands, as it fixes them at sixteen and a half years' purchase, according to our higher rate of interest on money. But though this rule for estimating the true value of land, and of the improvements made by marling, may be unquestionable in theory, still a practical objection will be presented by the well known fact that the income and profits of farmers are not increased in proportion to such improvements, nor is there found such a vast disproportion as this rule of estimating values would show, between the profits of the tillers of poor and of rich land. These positions are admitted to be generally well founded—

ut it is denied that they invalidate the previous stimates. A farmer may, and generally does, btain less gross product from a large or a rich arm, than his more necessitous, and therefore nore attentive and economical neighbor gets from smaller or poorer farm, in proportion to the producing power of each; and even the same persons, when young and needy, have often made more rofit according to their means, than afterwards when relieved from want, and having land increased to a quadruple power of production. These, and similar facts, however general, only re examples of the obvious truth that the profits f land depend principally on the industry, economy, and good management of the cultivator—and hat many a farmer who can manage well a mall or poor farm, is more deficient in industry, conomy, or the increased degree of knowledge equired, when possessed of much more abundant esources. In short, if these considerations were o direct or influence our estimates, we should not e comparing and estimating the value of lands, ut the value of the care and industry bestowed n their management.

Another objector may ask, "If any poor land is aised in value (according to this estimate) from ne dollar to thirty by marling, would a purchaser nake a judicious investment of his capital, by buying this improved land at thirty dollars?" I would nswer in the affirmative, if our view was confined o this particular means of investing farming capital. The purchaser would get a clear interest of ix per cent.—which is always a good return from and, and is twice as much as all Lower Virginia ow yields. But if such a purchase is compared with other means of acquiring land so improved, would be extremely injudicious—because thirty ollars expended in purchasing and marling such and, would serve both to acquire and improve five r six acres.

Estimates of the expenses required for marling re commonly erected on as improper grounds, as hose of its profits. We never calculate the cost f any old practice. We are content to clear woodland that afterwards will not pay for the expense of tillage—to keep under the plough, land educed to five bushels of corn to the acre—to uild and continue to repair miles of useless and erishable fences—to make farm-yard manure though not much of this fault,) and apply it to cid soils—without once calculating whether we ose or gain by any of these operations. But let ny new practice be proposed, and then every one egins to count its cost—and on such erroneous remises, that if applied to every kind of farm labor, the estimate would prove that the most fertile and known, could scarcely defray the expenses of ts cultivation.

According to estimates made with much care nd accuracy, the cost of an uncommonly expensive job of marling, four thousand and thirty-six ushels in quantity, in 1824, amounted to five dollars and thirty-five cents the acre, for five hundred nd ninety-eight bushels of marl. This quantity was much too great: four hundred bushels would ave been quite enough for safety and profit, and would have reduced the whole expense, including every necessary preparation, to three dollars and ifty-eight cents the acre. The earth which was aken off, to uncover the bed of marl, was considerably thicker than the marl itself. The road from the pit ascended hills amounting to forty feet of perpendicular elevation—and the average distance to the field was eight hundred and forty-seven yards.

In 1828, I began to marl another tract of land, where the difficulties were less. The labor bestowed served to carry out and spread six thousand eight hundred and ninety-two tumbril loads, on one hundred and twenty acres of land, being an average of two hundred and fifty-nine bushels to the acre. The exhausted state of the soil made heavier dressing unsafe. The whole expense of the operation, including all the preparatory labor, amounted to two dollars and eight cents for each acre marled—or eighty-three hundredths of a cent for each heaped bushel of marl. [Appendix L.]

It is impossible to carry on marling to advantage, or with any thing like economy, unless it is made a regular business, to be continued throughout the year or a specified portion of it, by a laboring force devoted to that purpose, and not allowed to be withdrawn for any other. Instead of proceeding on this plan, most persons who have begun to marl, attempt it in the short intervals of leisure, afforded between their different farming operations—and without lessening for this purpose, the extent of their usual cultivation. Let us suppose that preparations have been made, and on the first opportunity, a farmer commences marling with zeal and spirit. But every new labor is attended by causes of difficulty and delay, and a full share of these will be found in the first few days of marling. The road is soft for want of previous use, and if the least wet, soon becomes miry. The horses, unaccustomed to carting, balk at the hills, or only carry half loads. Other difficulties occur from the awkwardness of the laborers, and the inexperience of their master—and still more from the usual unwillingness of his overseer to devote any labor to improvements which are not expected to add to the crop of that year. Before matters can get straight, the leisure time is at an end: the work is stopped, and the road and pit are left to get out of order, before making another attempt some six months after, when all the same vexatious difficulties are again to be encountered.

If only a single horse was employed in drawing marl throughout the year, at the moderate allowance of two hundred working days, and one hundred bushels carried out for each, his year's work would amount to twenty thousand bushels, or enough for more than sixty acres. This alone would be a great object effected. But besides, this plan would allow the profitable employment of any amount of additional labor. When at any time, other teams and laborers could be spared to assist, though for only a few days, every thing is ready for them to go immediately to work. The pit is drained, the road is firm, and the field marked off for the loads. In this way, much labor may be obtained in the course of the year, from teams that would otherwise be idle, and laborers whose other employments would be of but little importance. The spreading of marl on the field, is a job that will always be ready to employ any spare labor: and throwing off the covering earth from an intended digging of marl, may be done, when rain, snow, or severe cold, have rendered the earth unfit for almost every other kind of labor.

Another interesting question respecting the expense of this improvement is, to what distance from the pit may marl be profitably carried? If the amount of labor necessary to carry it half a mile is known, it is easy to calculate how much more will be required for two or three miles. The cost of teams and drivers is in proportion to the distance travelled—but the pit and field labor, is not affected by that circumstance. At present, when so much poor land, abundantly supplied with fossil shells, may be bought at from two dollars to four dollars the acre, a farmer had better buy and marl a new farm, than to move marl even two miles to his land in possession. But this would be merely declining one considerable profit, for the purpose of taking another much greater. Whenever the value of marl is properly understood, and our lands are priced according to their improvements, or their capability of being improved from that source, as must be the case hereafter, then this choice of advantages will no longer be offered. Then rich marl will be profitably carted miles from the pits, and perhaps conveyed by water as far as it may be needed. A bushel of such marl as the bed on James River, described page 49, is as rich in calcareous earth alone, as a bushel of slaked lime will be after it becomes carbonated—and the greater weight of the first, is a less disadvantage for water carriage, than the price of the latter. Farmers on James River who have used lime as manure to great extent and advantage, might more cheaply have moved rich marl twenty miles by water, as it would cost nothing but the labor of digging and transportation.

Within the short time that has elapsed since the first publication of the foregoing passages in the first edition of this essay, the transportation of marl by water carriage has been commenced on James River, and has been carried on with more facility and at less expense, than was anticipated. The farmers who may profit by this new mode of using marl, will be indebted to the enterprise of C. H. Minge, Esq. of Charles City, for the making a full and satisfactory experiment of the business on a large scale. [See Appendix M.]

The objections to carrying marl unusual distances, admitted above, apply merely to improvements proposed for field culture. But it would be profitable, even under existing circumstances, for rich marl to be carried five miles by land, or one hundred miles by water, for the purpose of being applied to gardens, or other land kept under perpetual tillage, and receiving frequent and heavy coverings of putrescent manure. In such cases, independent of the direct benefit which the calcareous earth might afford to the crops, its power of combining with putrescent matters, and preventing their waste, would be of the utmost importance. If the soil was acid, the making it calcareous would enable half the usual supplies of manure, to be more effective and durable than the whole had been. There are other uses for marl, about dwelling houses and in towns, which should induce its being carried much farther than mere agricultural purposes would warrant. I allude to the use of calcareous earth in preserving putrescent matters, and thereby promoting cleanliness, and health. This important subject will hereafter be separately considered.

Either lime or good marl may hereafter be profitably distributed over a remote strip of poor land, by means of the rail road now constructing fro Petersburg to the Roanoke: providing the pr prietors do not imitate the over greedy policy the legislature of Virginia, in imposing tolls o manures passing through the James River cana If there was no object whatever in view, but draw the greatest possible income from tolls c canals and roads, true policy would direct that a manures should pass from town to country tc free. Every bushel of lime, marl, or gypsun thus conveyed, would be the means of bringin back in future time, more than as much whe or corn—and there would be an actual gain i tolls, besides the twenty fold greater increase the wealth of individuals and the state. Woo ashes, after being deprived of their potash, hav calcareous earth, and a smaller proportion of pho phate of lime, as their only fertilizing ingredient and both together do not commonly make mo than there is of calcareous earth in the same bu of good marl. Yet drawn ashes have been pu chased largely from our soap factories, at fo cents the bushel, and carried by sea to be sold f manure to the farmers of Long Island. Excep for the proportion of phosphate of lime which the contain, drawn ashes are simply artificial marl- more fit for immediate action, by being fine divided, but weaker in amount of calcareous eart than our best beds of fossil shells.

The argument in support of the several pr positions which have been discussed through many chapters, is now concluded. However un skilfully, I flatter myself that it has been effectual used; and that the general deficiency in our soi of calcareous earth—the necessity of supplyir it—the profit by that means to be derived—a the high importance of all these considerations- have been established too firmly to be shaken either arguments or facts.

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## CHAPTER XIX.

THE USE OF CALCAREOUS EARTH RECOM MENDED TO PRESERVE PUTRESCENT MA NURES, AND TO PROMOTE CLEANLINE AND HEALTH, ESPECIALLY IN TOWNS.

The operation of calcareous earth in enrichi barren soils, has been traced, in a former part this essay, to the chemical power possessed by th earth of combining with putrescent matters, with the products of their fermentation—and that manner, preserving them from waste, for t use of the soil, and for the food of growing plan That power was exemplified by the details of experiment, (page 31,) in which the carcass of animal was so acted on, and its enriching prope ties secured. That trial of the putrefaction of a mal matter in contact with calcareous earth, w commenced with a view to results very differe from those which were obtained. Darwin sa that *nitrous acid* is produced in the process of f mentation, and he supposes the *nitrate of lime* be very serviceable to vegetation.* As the trous acid is a gas, it must pass off into the a

*Darwin's Phytologia, pp. 210 and 224. Dublin E tion.

under ordinary circumstances, as fast as it is formed, and be entirely lost. But as it is strongly attracted by lime, it was supposed that a cover of calcareous earth would arrest it, and form a new combination, which, if not precisely nitrate of lime, would at least be composed of the same elements, though in different proportions. To ascertain whether any such combination had taken place, when the manure was used, a handful of the marl was taken, which had been in immediate contact with the carcass, and thrown into a glass of hot water. After remaining half an hour, the fluid was poured off, filtered, and evaporated, and left a considerable proportion of a white soluble salt (supposed eight or ten grains.) I could not ascertain its kind—but it was not deliquescent, and therefore could not have been the nitrate of lime. The spot on which the carcass lay, was so strongly impregnated by this salt, that it remained bare of vegetation for several years, and until the field was ploughed up for cultivation.

But whatever were the products of fermentation saved by this experiment, the absence of all offensive effluvia throughout the process sufficiently proved that little or nothing was lost—as every atom must be, when flesh putrefies in the open air: and I presume that a cover of equal thickness of clay, or sand, or any mixture of both, without calcareous earth, would have had very little effect in arresting and retaining the aeriform products of putrefaction. All the circumstances of this experiment, and particularly the good effect exhibited by the manure when put to use, prove the propriety of extending a similar practice. In the neighborhood of towns, or wherever else the carcasses of animals, or any other animal substances subject to rapid and wasteful fermentation, can be obtained in great quantity, all their enriching powers might be secured, by depositing them between layers of marl, or calcareous earth in any other form. On the borders of the Chowan, immense quantities of herrings are often used as manure, when purchasers cannot take off the myriads supplied by the seines. A herring is buried under each corn-hill, and fine crops are thus made as far as this singular mode of manuring is extended. But whatever benefits may have been thus derived, the sense of smelling, as well as the known chemical products of the process of animal putrefaction, make it certain that nine-tenths of all this rich manure, when so applied, must be wasted in the air. If those who fortunately possess this supply of animal manure, would cause the fermentation to take place and be completed, mixed with and enclosed by marl, in pits of suitable size, they would increase prodigiously both the amount and permanency of their acting animal manure, besides obtaining the benefit of the calcareous earth mixed with it.

But without regarding such uncommon, or abundant sources for supplying animal matter, every farmer may considerably increase his stock of putrescent manure, by using the preservative power of marl, and all the substances that might be so saved, are not only now lost to the land, but serve to contaminate the air while putrefying, and perhaps to engender diseases. The last consideration is of most importance to towns, though worthy of attention every where. Whoever will make the trial will be surprised to find how much putrescent matter may be collected from the dwelling house, kitchen, and laundry of a family: and which if accumulated (without mixture with calcareous earth,) will soon become so offensive as to prove the necessity of putting an end to the practice. Yet it must be admitted that when all such matters are scattered about (as is usual both in town and country,) over an extended surface, the same putrefaction must ensue, and the same noxious effluvia be evolved, though not enough concentrated to be very offensive, or even always perceptible. The same amount is inhaled—but in a very diluted state, and in small, though incessantly repeated doses. But if mild calcareous earth in any form (and fossil shells or marl present much the cheapest,) is used to cover and mix with the putrescent matters so collected, they will be prevented from discharging offensive effluvia, and preserved to enrich the soil. A malignant and ever acting enemy will be converted to a friend and benefactor.

The usual dispersion and waste of such putrescent and excrementitious matters about a farm house, though a considerable loss to agriculture, may take place without being very offensive to the senses, or certainly injurious to health. But the case is widely different in towns. There, unless great care is continually used to remove or destroy filth of every kind, it soon becomes offensive, if not pestilential. During the last summer, (1832) when that most horrible scourge of the human race, the Asiatic cholera, was desolating some of the towns of the United States, and all expected to be visited by its fatal ravages, great and unusual exertions were every where used to remove and prevent the accumulation of filth, which if allowed to remain, it was supposed would invite the approach, and aid the effects of the pestilence. The efforts made for that purpose served to show what a vast amount of putrescent matter existed in every town, and which was so rapidly reproduced, that its complete riddance was impossible. Immense quantities of the richest manures, or materials for them, were washed away into the rivers—caustic lime was used to destroy them—and the chloride of lime to decompose the offensive products of their fermentation, when that process had already occurred. All this amount of labor and expense was directed to the complete destruction of what might have given fertility to many adjacent fields—and yet served to cleanse the towns but imperfectly, and for a very short time. Yet the object in view might have been better attained by the previous adoption of the proper means for preserving these putrescent matters, than by destroying them.—These means would be to mix or cover all accumulations of such matters with rich marl, (which would be the better for the purpose if its shells were in small particles,) and in such quantity as the effect would show to be sufficient. But much the greater part of the filth of a town is not, and cannot be accumulated; and from being dispersed, is the most difficult to remove, and is probably the most noxious in its usual course of fermentation. This would be guarded against by covering thickly with marl the floor of every cellar and stable, back yard and stable lot. Every other vacant space should be lightly covered. The same course pursued on the gardens and other cultivated grounds, would be sufficiently compensated by the increased product that would be obtained: but independent of that consideration, the manures

there applied would be prevented from escaping into the air—and being wholly retained by the soil, much smaller applications would serve. The level streets ought also to be sprinkled with marl, and as often as circumstances might require. The various putrescent matters usually left in the streets of a town alone serve to make the mud scraped from them a valuable manure; for the principal part of the bulk of street mud is composed merely of the barren clay, brought in upon the wheels of wagons from the country. Such a cover of calcareous earth would be the most effectual absorbent and preserver of putrescent matter, as well as the cheapest mode of keeping a town always clean. There would be less noxious or offensive effluvia, than is generated in spite of all the ordinary means of prevention; and by scraping up and removing the marl after it had combined with and secured enough of putrescent matter, a compost would be obtained for the use of the surrounding country, so rich and so abundant, that its use would repay a large part, if not the whole of the expense incurred in its production. Probably one covering of marl for each year would serve for most yards, &c., but if required oftener, it would only prove the necessity for the operation, and show the greater value in the results. The compost that might be obtained from spaces equal to five hundred acres in a populous town, would durably enrich thrice as many acres of the adjacent country: and after twenty years of such a course, the surrounding farms might be capable of returning to the town a ten fold increased surplus product. After the qualities and value of the manure so formed were properly estimated, it would be used for farms that would be out of the reach of all other calcareous manures. Carts bringing country produce to market might with profit carry back loads of this compost eight or ten miles. The annual supply that the country might be furnished with, would produce very different effects from the putrescent and fleeting manure now obtained from the town stables. Of the little durable benefit heretofore derived from such means, the appearance of the country offers sufficient testimony. At three miles distance from some of the principal towns in Virginia, more than half the cultivated land is too poor to yield any farming profit. The surplus grain sent to market is very inconsiderable—and the coarse hay from the wet meadows can only be sold to those who feed horses belonging to other persons—and to whom that hay is most desirable that is least likely to be eaten.

But even if the waste and destruction of manure in towns was counted as nothing, and the preservation of health by keeping the air pure was the only object sought, still calcareous earth, as presented by rich marl, would serve the purpose far better than quicklime. It is true, that the latter substance acts powerfully in decomposing putrescent animal matter, and destroys its texture and qualities so completely, that the operation is commonly and expressively called "burning" the substances acted on. But to use a sufficient quantity of quicklime to meet and decompose all putrescent animal matters in a town, would be intolerably expensive, and still more objectionable in other respects. If a cover of dry quicklime in powder was spread over all the surfaces requiring it for this purpose, the town would be unfit to live in; and the nuisance would be scarcely less, when rain had changed the suffocating dust to an adhesive mortar. Woollen clothing, carpets, and even living flesh would be continually sustaining injury from the contact. No such objections would attend the use of mild calcareous earth: and this could be obtained probably for less than one-fifth of the cost of quicklime, supposing an equal quantity of pure calcareous matter to be obtained in each case. At this time the richest marl on James River may be obtained at merely the cost of digging, and its carriage by water, which if undertaken on a large scale, could not exceed, and probably would not equal three cents the bushel.

The putrescent animal matters that would be preserved and rendered innoxious by the general marling of the site of a town, would be mostly such as are so dispersed and imperceptible that they would otherwise be entirely lost. But all such as are usually saved in part, would be doubled in quantity and value, and deprived of their offensive and noxious qualities by being kept mixed with calcareous earth. The importance of this plan being adopted with the products of privies, &c. is still greater in town than country. The various matters so collected and combined should never be applied to the soil alone, as the salt derived from the kitchen, and the potash and soap from the laundry, might be injurious in so concentrated a form. When the pit for receiving this compound is emptied, the contents should be spread over other and weaker manure, before being applied to the field.

Towns might furnish many other kinds of rich manure, which are now lost entirely. Some of these particularly require the aid of calcareous earth to be secured from destruction by putrefaction, and others, though not putrescent, are equally wasted. The blood of slaughtered animals, and the waste and rejected articles of wool, hair, feathers, skin, horn and bones, all are manures of great richness. We not only give the flesh of dead animals to infect the air, instead of using it to fertilize the land, but their bones which might be so easily saved, are as completely thrown away. Bones are composed of phosphate of lime and gelatinous animal matter, and when crushed, form one of the richest and most convenient manures in the world. They are shipped in quantities from the continent of Europe to be sold for manure in England. The fields of battle have been gleaned, and their shallow graves emptied for this purpose: and the bones of the ten thousand British heroes who fell on the field of Waterloo, are now performing the less glorious, but more useful purpose of producing as manure bread for their brothers at home.

There prevails a vulgar but useful superstition that there is "bad luck" in throwing into the fire any thing, however small may be its amount or value, that can serve for the food of any living animal. It is a pity that the same belief does not extend to every thing that as manure can serve to feed growing plants—and that even the parings of nails and clippings of beards are not used (as in China) in aid of this object. However small each particular source might be, the amount of all the manures that might be saved, and which are now wasted, would add incalculably to the usual means for fertilization. Human excrement, which is scarcely used at all in this country, is stated to be even richer than that of birds; and if all the enriching matters were preserved that are derived

›t only from the food, but from all the habits of ɪn, there can be no question but that a town of ɪ thousand inhabitants, from those sources alone, ight enrich more land than could be done from . many cattle.

The opinions here presented are principally ɪnded on the theory of the operation of calca- ɪus manures, as maintained in the foregoing part this essay: but they are also sustained to con- ɪderable extent by facts and experience. The ɪst undeniable practical proof of one of my po- ɪions, is the power of a cover of marl to pre- ɪnt the escape of all offensive effluvia from the ɪst putrescent animal matters. Of this power have made continued use for about eighteen ɪnths, and know it to be more effectual than ɪicklime, even if the destructive action of the ter was not objectionable. Quicklime forms ɪw combinations with putrescent substances, and thus combining, throws off effluvia, which ɪugh different from the products of putrescent ɪtter alone, are still disagreeable and offensive. ɪild lime on the contrary absorbs and preserves ery thing—or at least prevents the escape of y offensive odor being perceived. Whether pu- ɪscent vegetable matter is acted on in like man- r by calcareous earth, cannot be as well tested our senses, and therefore the proof is less satis- ɪtory. But if it is true that calcareous earth ɪs by combining putrescent matters with the ɪl, and thus preventing their loss, (as I have en- ɪavored to prove in Chapter VIII.) it must follow ɪt to the extent of such combination, the forma- ɪn and escape of all volatile products of putrefac- ɪn will also be prevented.

But it will be considered that the most impor- ɪt inquiry remains to be answered: Has the ap- ɪcation of calcareous manures been found in prac- ɪe decidedly beneficial to the health of the resi- ɪnts on the land? I answer, that long experience, ɪd the collection and comparison of numerous ɪts derived from various sources, will be re- ɪired to remove all doubts from this question; and ɪvould be presumptuous in any individual to of- as sufficient proof, the experience of only ten twelve years on any one farm. But while ad- ɪtting the insufficiency of such testimony, I as- ɪt that so far, my experience decidedly supports ɪ position. My principal farm until within some ɪr or five years, was subject in a remarkable de- ɪe to the common mild autumnal diseases of our ɪ country. Whether it is owing to marling, or ɪer unknown causes, these bilious diseases have ɪce become comparatively very rare. Neither ɪs my opinion in this respect, nor the facts that ɪve occurred on my farm, stand alone. Some ɪer persons are equally convinced of this change other land as well as on mine. But in most cases ɪere I have made inquiries as to such results, ɪthing decisive had been observed. The hope ɪt other persons may be induced to observe and ɪort facts bearing on this important point, has in ɪt caused the appearance of these crude and per- ɪps premature views.

Even if my opinions and reasoning should ap- ɪr sound, I am aware that the practical appli- ɪion is not to be looked for soon; and that the ɪeme of using marl in towns is more likely to met by ridicule, than to receive a serious and ɪentive examination. Notwithstanding this an- ɪipation, and however hopeless of making con- verts either of individuals or of corporate bodies, I will offer a few concluding remarks on the most obvious objections to, and benefits of the plan. The objections will all be resolved into one—namely, the expense to be encountered. The expense certainly would be considerable; but it would be amply compensated by the gains and benefits. In the first place the general use of marl as proposed for towns, would serve to insure cleanliness, and purity of the air, more than all the labors of their Boards of Health and their scavengers, even when acting under the dread of approaching pestilence. Secondly, the putrescent manures produced in towns, by being merely preserved from waste, would be increased ten-fold in quantity and value. Thirdly, all existing nuisances and abominations of filth would be at an end, and the beautiful city of Richmond (for example) would not give offence to our nostrils, almost as often as it offers gratification to our eyes. Lastly, the marl after being used until saturated with putrescent matter, would retain all its first value as calcareous earth, and be well worth purchasing and removing to the adjacent farms, independent of the enriching manure with which it would be loaded. If these advantages can indeed be obtained, they would be cheaply bought at any price necessary to be encountered for the purpose.

The foregoing part of this chapter was first published in the Farmers' Register, (for July 1833) and as supplementary to this Essay. That publication drew some attention from others to the subject, and served to elicit many important facts, of which I had been before altogether ignorant, in support of the operation of calcareous earth in arresting the effects of *malaria*, or the usual autumnal diseases of the southern states and other similar regions. These facts, together with the result of my own personal experience, extended through two more autumns (or sickly seasons as commonly called here and farther south,) since the first publication of these views, will now be submitted. Most of the facts derived from other persons relate to one region—the "rotten limestone lands" of Southern Alabama: but that region is extensive, of remarkable and well known character and peculiarities, and the evidence comes from various sources, and is full, and consistent in purport. The facts will be here embodied, and the more important statements from which they are drawn, will be presented more fully in the Appendix. [See N.]

The first fact brought out, was, that in the town of Mobile, near the Gulf of Mexico, the streets actually had been paved with shells—thus presenting precisely such a case as I recommended, though not with any view to promoting cleanliness or health. The shells had been used merely as a substitute for stones, which could not be so cheaply obtained. Nor had the greatly improved healthiness of Mobile since the streets were so covered, (of which there is the most ample and undoubted testimony,) been attributed to that cause, until the publication of the foregoing opinions served to connect them as cause and effect. This can scarcely be doubted by those who will admit the theory of the action of calcareous earth —and the remarkable change from unhealthiness in Mobile, to comparative healthiness, is a very strong exemplification of the truth of the theory. But it is not strange, that when so many other causes might (and probably did) operate to arrest

disease, that none should have considered the chemical operation of the shelly pavement as one of them, and still less as the one by far the most important. The paving of streets, (with any material) draining and filling up wet places, substituting for rotting wooden buildings new ones of brick and stone—and especially the operation of destructive and extensive fires—all we know operate, (and particularly the last,) to improve the healthiness of towns: and all these operated at Mobile, as well as shelling the streets. Neither was the shelling so ordered as to produce its best effect for health. The streets, alleys, and many yards and small vacant lots were covered, and so far the formation and evolving of pestilential effluvia were lessened. But as this was not the object in view, and indeed the chemical action of shells not thought of, the process was incomplete, and must necessarily be less effectual than it might have been made. The shelling ought to have been extended to every open spot where filth could accumulate—to every back yard, in every cellar, and made the material of the floor of every stable, and every other building of which the floor would otherwise be of common earth. In addition, after a sufficient lapse of time to saturate with putrescent matters the upper part of the calcareous layer, and thus to make it a very rich compound, there should be a partial or total removal of the mass, and a new coating of shells laid down. The value of the old material, as manure, would probably go far towards paying for this renewal: and if it is not so renewed, the calcareous matter cannot combine with more than a certain amount of putrescent matters—and after being so saturated, can have no farther effect in saving such matters for use, or preventing them from having their usual evil course.

The burning of towns is well known to be a cause of the healthiness of the places being greatly improved, and that that effect continues after as many buildings, or more, have replaced those destroyed by fire. Indeed this improvement is considered so permanent, as well as considerable, that the most sweeping and destructive conflagrations of some of our southern towns, have been afterwards acknowledged to have proved a gain, and a blessing. The principal and immediate mode of operation of this universally acknowledged cause, is usually supposed to be the total destruction, by the fire, of all filth and putrescent matters—and in a less degree, and more gradually, by afterwards substituting brick and stone for wooden buildings, which are always in a more or less decaying state. But though these reasons have served heretofore to satisfy all, as to the beneficial consequences of fires, surely they are altogether inadequate as causes for such great and durable effects. The mere destruction of all putrescent matters in a town at any one time, would certainly leave a clear atmosphere, and give strong assurance of health being improved for a short time afterwards: but these matters would be replaced probably in the course of a few months, by the residence of as many inhabitants, and the continuance of the same general habits—and most certainly this cause would lose all its operation by the time the town was rebuilt. But there is one operation produced by the burning of a town, which is far more powerful—which in fact is indirectly the very practice which has been advocated —and the effect of which, if given its due weigh furnishes proof of the theory set forth, by the ex perience of every unhealthy town which has su fered much from fire. If any estimate is made the immense quantity of mild calcareous ear which is contained in the plastering and bric work of even the wooden dwelling houses of town, (and still more from those built of masonr it must be admitted that all that material bei separated, broken down, (soon or late,) and spre by the burning of the houses, and pulling dov their ruins, is enough to give a very hea cover of calcareous earth to the whole space land burnt over. It is to this operation, in a greater degree than to all others, that I attrib the beneficial effects to health of the burning towns.

I proceed to the facts derived from the extensi body of prairie lands in Alabama which rest a substratum of soft limestone, or rich indura clay marl. It was from these remarkable so that the specimens were obtained which were scribed at page 22. Some of these, indeed that have been examined by chemical tests of high and dry prairie lands, contain calcare earth in larger proportions than any soils of c siderable extent in the United States that I ha seen or tested. The specimens not containi free calcareous earth are of the class of neut soils; and the calcareous earth, which doubtl they formerly contained, and from which they rived their peculiar and valuable qualities, may supposed only to be concealed by the accumulat of vegetable matter, according to the gene views submitted in Chapter VII. The more descriptions of the soils of this remarkable and tensive region which will be placed in the App dix, [at N] render it unnecessary to enlarge m here. It will be sufficient to sum up concisely facts there exhibited—and which agree with rious other private accounts which have been ceived from undoubted sources of informat The deductions from these facts, and their acc ance with the theory of the operation of calcare matter, are matters of reasoning, and as such, submitted to the consideration and judgemen readers.

The soil of these prairie lands is very rich, cept the spots where the soft limestone rises to surface, and makes the calcareous ingredient cessive: in the specimen formerly mentioned, pure calcareous matter formed 59 parts in the h dred of this "bald prairie" land. The soil ge ally has so little of sand, that nothing but the careous matter which enters so largely into composition prevents it being so stiff and intra ble, that its tillage would be almost impractica yet it is friable and light when dry, and eas till. But the superfluous rain water cannot and pass off, as in sandy or other pervious la but is held in this close and highly absorbent which throughout winter is thereby made a mire, unfit to prepare for tillage, and scarcely p ticable to travel over. This water-holding qu of the soil, and the nearness to the surface of hard marly substratum, deprive the countr natural springs and running streams: and be the important discovery was made that pure w might be obtained by boring from 300 to 700 through the solid calcareous rock, the inhabit used the stagnant rain water collected in

ıich was very far from pure, or palatable. ıder all these circumstances, added to the rank rbage of millions of acres annually dying and composing under a southern sun, it might have en counted on as almost certain, that such a ıntry would have proved very unhealthy: yet reverse is the fact, and in a remarkable degree. ıe healthiness of this region is so connected with, d limited by, the calcareous substratum and soil, ıt it could not escape observation: and they have en considered as cause and effect by those who d no theory to support, and who did not spend hought upon the mode in which was produced e important result which they so readily admit-d. Their testimony therefore is in this respect e more valuable, because it cannot be suspected. he intelligent author of the extract from the *uthern Agriculturist*, which will be given in the ppendix [N] is altogether unknown to me—and is presumed that he had never heard of this es-y, nor of these views of the action of calcareous arth.

After deducing the foregoing mass of evidence, r which I am indebted to others, it will appear ery unimportant to add what will follow from my ersonal observation—especially, as the opinion as been expressed above, that the experience of ıy one individual, on any one farm, or in any one cation, though continued for ten or twelve years, ıust be very insufficient as proof of a permanent ıange of healthiness, and of the actual causes of ıch changes. But, as in the absence of more triking facts, and of practical proofs, my own li-ıited experience was formerly brought forward— is proper here to add, that the two autumns that ave since passed have brought no circumstances weaken the opinions advanced, and many that ave served, on the contrary, to strengthen them.

On my principal farm, Coggin's Point, the po-ition of the homestead was always most inconve-ıiently situated, and became the more so as the learing and improvement of the poorer and more emote parts of the land were extended. For this eason, in addition to others, the farm buildings, ınd negroes' dwellings had been gradually re-moved, as the expense could be best encountered, ıntil the old homestead was entirely abandoned in 1831, for a more eligible location. This would prevent the different degree of healthiness found here, before and since marling, from presenting a fair statement or proof. But still, there is no doubt of the general results showing a great and decided improvement in respect to health—and this was evident, before as well as since the removal of the dwelling place of the slaves. The greater number of these had been moved to an interme-diate location, (with a view to health) before these benefits of marling were either felt, or anticipated —where a portion of them remained until within the last few years: and the circumstances attend-ing this location, furnish ground for the opinion maintained, which is not liable to the objection re-ferred to.

The poor farm (Shellbanks) which was made a summer residence for my family in 1828 and the two succeeding years, and a permanent dwelling place since 1831, was marled to the extent of 120 acres, including all the land around the houses, in 1828; and in a few succeeding years, the space marled amounted to more than 300 acres. During this time, the yard was covered heavily with marl —and in 1832, when the approach of Asiatic cho-lera caused such alarm, the floor of the cellar of the house, (which is very damp,) the stable floor, and stable yard, were also covered, and every other vacant spot. In addition, the plan of collecting for manure all putrescent animal matters in a pit and covering or mixing them frequently with marl, has been pursued for several years, though not with as much care and economy as ought to be used. In this pit, for experiment as much as for profit, the carcasses of animals have been several times placed, and preserved (as before) from giving out any offensive odor, until their very slow decom-position was at an end, merely by the covering of marl. The health of the family, during the first two or three autumns, was about as good as on what are considered healthy places in the tide-wa-ter region of Virginia—all of which are more or less subject to bilious disorders in autumn, though deserving well (as indeed does the whole country) to be considered more than usually exempt from all other diseases. We had among the members of a large family, some intermittents, and some more severe bilious fevers during that time. But there has been a still greater and unlooked for im-provement since—and for the last two years, I be-lieve that all residing permanently at this place, have enjoyed as good health, as could be hoped for in any situation in the United States. Among the domestic servants and their young children, last autumn, there were a few slight agues, (which were attributed to some of those acts of impru-dence to which negroes are so notoriously addict-ed, even if not necessarily exposed,) and which were scarcely worth notice, but as exceptions to the general healthiness. The land not being then tilled, there were no field laborers. Among my own family and other white persons who were permanent residents, there was not a single ague, or the slightest disease to be counted as one of climate, or proceeding from *malaria*. But I repeat, that many such facts are necessary, and much time, and the testimony of many different persons from various places to be brought together, before the causes can be fully admitted of such myste-rious effects, as disease and its removal. It is to be hoped that the facts and deductions here pre-sented, however defective, may, at least, serve to attract the attention of many other and more com-petent investigators to this highly important sub-ject.

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## CHAPTER XX.

### DIRECTIONS FOR DIGGING AND CARTING MARL.

The great deposite of fossil shells, which cus-tom has miscalled marl, is in many places exposed to view in most of the lands that border on our tide-waters, and on many of their small tributary streams. Formerly, it was supposed to be limit-ed to such situations: but since its value as a ma-nure has caused it to be more noticed, and sought after, marl has been found in many other places. It is often discovered by the digging of wells, but lying so deep, that its value must be more highly estimated than at present, before it will be dug for manure. From all the scattered evidences of the

presence of this deposite, it may be inferred, that it lies beneath nearly every part of our country between the sea and the granite ridge which forms the falls of all our rivers. It is exposed, where it rises, and where cut through by the deep ravines of hilly land, and the courses of rivers—and concealed by its dips, and the usual level surface of the country. The rich tracts of neutral soil on James River, such as Shirley, Westover, Brandon, and Sandy Point, seem to have been formed by alluvion, which may be termed recent, compared to that of our district in general: and in these, no marl has been found, though it is generally abundant in the adjacent higher lands.* Fresh-water muscle shells are sometimes found in thin layers (from a few inches to two feet thick) both on those lands, and others—but generally near the surface, and always far above the deposite of sea shells, found under the high land. These two layers of different kinds of shells are separated by a thickness of many feet of earth, containing no shells of any kind. From these appearances, it would seem that this tract of country was, for ages, the bottom of the sea—then covered by earth—then the bottom of a fresh-water lake—and finally made dry land. Muscle shells are richer than the others, as they contain much gelatinous and enriching animal matter. On this account, the earth with which muscle shells are found mixed, is a rich black mould. Most persons consider these beds of muscle shells as artificially formed by the Indians, who are supposed to have collected the muscles, for food, and left the shells, where the fish were consumed. There are some strong reasons which may be adduced both to sustain and to oppose this opinion. But whatever may be the origin of these collections of muscle shells, it does not affect their qualities as manure for the soils in which they are found, or for others to which they may be removed.

Neither the fossil sea shells, nor the earth mixed with them are supposed to contain any putrescent matter—and this manure has been considered throughout this essay as being valuable *only as containing calcareous earth*. This, no doubt, is the only ingredient of any worth, in the great majority of cases. But sometimes there are other ingredients—which must be considered merely as exceptions to the general rule. One of these exceptions has already been stated, in the description of gypseous marl, (page 48:) and some oth[er] have been discovered since the publication of th[at] statement. A kind of earth containing a lar[ge] proportion of carbonate of magnesia, as well as carbonate of lime, has been found in Hanov[er.] Professor Rogers, of William and Mary Colleg[e,] has discovered in many of the marls of Lower V[ir]ginia, some proportion of the "green sand" of g[e]ologists, or what is itself called "marl," (anot[her] misapplication of that name,) in New Jersey, a[nd] which has there been found highly valuable [as] manure, though containing not a particle of the ca[r]bonate of lime, which constitutes the sole value [of] shells and calcareous manures in general. B[ut] however interesting may be the discovery of the[se] different ingredients, and however valuable th[ey] may prove as manures, still they are not to be co[n]sidered as treated of in this essay under any gen[e]ral observations on *marl*, which are intended to [be] applied simply to manure, the only useful ingr[e]dient of which, is the *carbonate of lime*. [Appe[n]dix O.]

More than forty kinds of sea shells are found [in] the beds of marl that I have worked witho[ut] counting any of very small size. Many kin[ds] would escape common observation, and still mo[re] would require the aid of a magnifying glass to [be] distinguished. Generally the shells are who[le,] but are much broken by digging, and the after op[e]rations. The white shells are rapidly reduce[d] after being mixed with an acid soil—but som[e] gray kinds, as scallop, and a variety of oyster, a[re] so hard as to be very long before they can act [as] manure. Some beds, and they are generally th[e] richest, have scarcely any whole shells, but a[re] formed principally of small broken fragment[s.] Of course the value of marl as a manure depen[ds] in some measure on what kinds of shells are mo[st] numerous, and their state of division, as well [as] upon the total amount of the calcareous ear[th] contained. The last is however by far the mo[st] important criterion of its value. The most ex[pe]rienced eye may be much deceived in th[e] strength of marl, and still more gross and dange[r]ous errors would be made by an inexperience[d] marler. The strength of a body of marl ofte[n] changes materially in sinking a foot in depth—al[]though the same changes may be expected to oc[]cur very regularly, in every pit sunk through th[e] same bed. Whoever uses marl, ought to kno[w] how to analyze it, which a little care will enab[le] any one to do with sufficient accuracy. Th[e] methods described in Chap. V. for ascertain[]ing the proportions of calcareous earth in soil[s,] will of course serve for the same purpose wit[h] marl. But as more minute directions may be ne[]cessary for many persons who will use this ma[]nure, and who ought to be able to judge of its va[]lue, an additional article on this subject will b[e] given in the Appendix. [See P.]

For want of attention to this only safe guid[e,] gross errors are often committed, and losses con[]tinually sustained. By relying on the eye only, [I] have known marl, or rather a calcareous sand, re[]jected as worthless, and thrown off at considerabl[e] cost of labor, to uncover worse marl below, wher[e] whole shells were visible: and on the contrar[y,] earth has been taken for marl, and used as such which had no calcareous ingredient whatever. The best marls for profitable use are generally such as show the fewest whole shells, or even larg[e]

*It seems however, from facts learned since the publication of the passage above, that marl is, or has been, below these alluvial lands, though only at considerable depths. This does not contradict the opinion expressed that no marl is to be found in such land. The deposites referred to were of much more ancient formation, and have been covered by the very different and peculiar bodies of land which now form not only the surface, but a depth as low as the level of the river. Benjamin Harrison, Esq., of Berkley, (a tract of such land as is above described,) has found on the river beach, and dug deeply into, a body of the earth described at page 49, which evidently was once full of shells, though now retaining neither shells nor any trace of carbonate of lime, except some few stony and insulated masses. It has also been very recently stated, that fossil shells have been found at the level of the river at Curle's Neck in Henrico. These are interesting facts, which ought to encourage searches for such deposites in every part of the low country.

agments—and would be passed by unnoticed some cases, or considered only as barren sand, equally worthless clay. But even if such miskes as these are avoided, every farmer using arl, without analyzing specimens frequently nd accurately, will lose by applying it in quantites either too great or too small.

If marl reaches the surface any where, it may be ost easily found by examining the beds of streams assing through the lowest land, or deepest raines. A few of the smallest particles of shells ound there, will prove that the stream passes rough marl somewhere above; and a careful exmination continued towards the source, will carcely fail to discover where the bed lies. Its sual direction is horizontal, or very little inined—and therefore if discovered any where long the sides of a narrow valley, it may genelly be found by digging on the opposite side, or lsewhere not very distant at the same elevation n the hill-side: and it is always nearer the surface n swells, or convex parts of the hill-side, than here it retreats and forms hollows. In the more vel parts of the country, the marl sometimes is ery near the surface of the lowest land, and yet not visible any where. In such situations parcularly, a cheap and convenient auger may be sed with much advantage in searching for marl: nd it is also useful to try the depth or quality of bed, even when its surface has been found. his tool may be made by welding a straight stem, alf an inch square and six or seven feet long, to common screw auger of about one inch and a alf bore. If it has been so much worn as to be seless as a carpenter's tool, it will serve for boring earth. A cross-piece for a handle should be ixed to slide over the stem, and be fastened by a mall screw at different elevations, as most conenient. Other pieces may be added to the stem, ttached by joints, so as to bore twelve or more eet deep. Dr. W. Cocke of Sussex, to whom I m indebted for this simple but useful tool, was nabled by its use to find a very valuable bed of marl which was no where visible at the surface, nd which he has since been using to great exent and advantage.

By proper examinations marl may be found at r near the surface through a vast extent of the ide-water region of the United States, where it as not yet been noticed. But still, under most ands it probably does not approach within twentyive or thirty feet of the surface, and if reached by ligging, would be covered by water, so as greatly o increase the difficulty of obtaining it from such lepths. Will these obstacles always debar from he benefit of this treasure half the great region inder which it lies? I think not: and though it vould be ridiculous now to propose such underakings, it will at some future time be found profitable to descend still greater depths for good marl: and shafts will be sunk and the water and marl lrawn out by horse power, or by steam engines, and the excavation carried on in the same manner as is done in coal mines.

Our beds of marl are either of a blue, or a yelowish color. The color of the first seems to have some connexion with the presence of water, as his kind is always kept wet, by water slowly oozing through it. The yellow marl is sometimes wet, but more generally dry, and therefore easier to work.* Unless very poor, all marls are sufficiently firm and solid for the sides of the pit to stand, when dug perpendicularly.

Where a bed of marl is dry and not covered by much earth, no directions are required for the pit work—except it be, that the pit should be long enough to allow the carts to descend to the bottom (when finished) and to rise out on a slope sufficiently gradual. This will prevent the necessity of twice handling the marl, by first throwing it out of the pit, and then into the carts, which must be done, if the pit is made too short, or its ends too steep, for the loads to be drawn out. No machine or contrivance will raise marl from the bottom of a pit, or a valley, so well as a horse-cart—and no pains will be lost, in enlarging the pit, and graduating the ascent out of it, to attain that object.

As marl usually shows on a hill-side, but little earth has to be moved to uncover the first pit. But the next, and each successive cover of earth, will be more thick, until it may be necessary to abandon that place and begin again elsewhere. But the quantity of covering earth need not be regarded as a serious obstacle, if it is not thicker than the marl below it. While that is the case, one pit completed will receive all the earth thrown from an equal space, for commencing another. When this proportion of earth is exceeded, it is necessary to carry it farther, by either carts or scrapers, and the labor is greatly increased.

For any extensive operation, it is much cheaper to take off a cover of earth, twelve feet thick, to obtain marl of equal depth, than if both the covering earth and marl were only three feet each. Whether the cover be thick or thin, two parts of the operation are equally troublesome, viz. to take off the mat of roots, and perhaps some large trees on the surface soil, and to clean off the surface of the marl, which is sometimes very irregular. The greater part of the thickest cover would be much easier to work. But the most important advantage in taking off earth of ten or more feet in thickness, is saving digging, by causing the earth to come down by its own weight. If time can be allowed to aid this operation, the driest earth will mostly fall, by being repeatedly undermined a little. But this is greatly facilitated by the oozing water, which generally fills the earth lying immediately on beds of wet marl. In uncovering a bed of this description, where the marl was to be dug fourteen feet, and ten to twelve feet of earth to remove, my labor was made ten-fold heavier, by digging altogether. The surface bore living trees, and was full of roots—there was enough stone to

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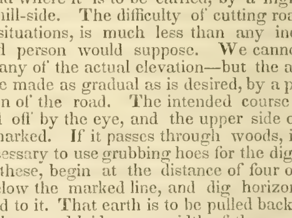
*The blue color of marl is not caused by merely the presence of water, or there would be no wet yellow marl. When both blue and yellow marl are seen in the same bed, the blue is always at bottom—and the line of division between the colors is well defined, and there is seen no gradual change of one to the other. I have lately observed (in 1834) that as intense and perfect a blue color as marl has ever been known to have, was given to what had been dry yellow marl, by its being used as a thick flooring for a stable yard, and kept covered with the rotting manure, and penetrated by its liquid oozings, which the marl was there placed to save. It may be inferred from this fact, that blue marls have received their color from some vegetable extract or other putrescent matter, dissolved in the water passing through the bed.

keep the edges of the grubbing hoes battered—and small springs and oozing water came out every where, after digging a few feet deep. A considerable part of the earth was a tough, sticky clay, kept wet throughout, and which it was equally difficult to get on the shovels, and to get rid of. Some years after, another pit was uncovered on the same bed, and under like circumstances, except that the time was the last of summer, and there was less water oozing through the earth. This digging was begun at the lowest part of the earth, which was a layer of sand, kept quite wet by the water oozing through it. With gravel shovels, this was easily cut under from one to two feet along the whole length of the old pit—and as fast as was desirable, the upper earth, thus undermined, fell into the old pit: and afterwards, when that did not take place of itself, the fallen earth was easily thrown there by shovels. As the earth fell separated into small but compact masses, it was not much affected by the water, even when it remained through the night before being shoveled away. No digging was required, except this continued shoveling out the lowest sand stratum, and whether clay, or stones, or roots, were mixed with the falling earth, they were easy to throw off. The numerous roots which were so troublesome in the former operation, were now an advantage, as they supported the earth sufficiently to let it fall only gradually and safely; and before the roots fell, they were almost clear of earth. The whole body of earth, notwithstanding all its difficulties, was moved off as easily as the driest could have been by digging altogether.

In working a pit of wet marl, no pains should be spared to drain it as effectually as possible. Very few beds are penetrated by veins of running water, which would deserve the name of springs—but water oozes very slowly through every part of wet marl, and bold springs often burst out immediately over its surface. After the form of the pit, and situation of the road are determined, a ditch to receive and draw off all the water, should be commenced down the valley, as low as the bottom of the pit is expected to be, and opened up to the work, deepening as it extends, so as to keep the bottom of the ditch on the same level with the bottom of the marl. It may be cheaper, and will serve as well, to deepen this ditch as the deepening of the pit proceeds. After the marl is uncovered the full size intended for the pit, (which ought to be large enough for carts to turn about on,) a little drain of four or five inches wide, and as many deep, (or the size made by the grubbing hoe used to cut it,) should be carried all around to intercept the surface or spring water, and conduct it to the main drain. The marl will now be dry enough for the carts to be brought on and loaded. But as the digging proceeds, oozing water will collect slowly; and aided by the wheels of loaded carts, the surface of the firmest marl would soon be rendered a puddle, and then quagmire. This may easily be prevented by the inclination of the surface. The first course dug off, should be much the deepest next the surface drain, (leaving a margin of a few inches of firm marl, as a bank to keep in the stream) so that the digging shall be the lowest around the outside, and gradually rise to the middle of the area. Whatever water may find its way within the work, whether from oozing, rain, or accidental burstings of the little surface drain, will run to the outside, the dip of whic should lead to the lower main drain. After th form is given to the surface of the area, very littl attention is required to preserve it; for if the su cessive courses are dug of equal depth from side t side, the previous dip will not be altered. Th sides or walls of the pit should be cut somethin without the perpendicular, so that the pit is mad one or two feet wider at bottom than top. Th usual firm texture will prevent any danger fro this overhanging shape, and several advantag will be gained from it. It gives more space f work—prevents the wheels running on the lowe and wettest parts—allows more earth to be di posed of, in opening for the next pit—and preven that earth tumbling into the next digging, whe the separating wall of marl is cut away. Th upper drain of the pit, which takes the surfac water, will hang over the one below, kept for th oozing water. The former remains unalter throughout the job, and may still convey the strea when six feet above the heads of the laborers i the pit. The lower drain of course sinks wit the digging. Should the pit be dug deeper tha the level of the receiving ditch can be sunk, a wa should be left between, and the remainder of th oozing water must be conducted to a little bas near the wall, and thence be baled or pumped int the receiving ditch. The passage for the carts t ascend from the pit should be kept on a suitab slope—and the marl forming that slope may b cut out in small pits, after the balance has bee completed.

If the marl is so situated that carts cannot b driven as low as the bottom, then the area mu be cut out in small pits, beginning at the back par and extending as they proceed, towards the roa leading out of the pit.

On high and broken land, marl is general found at the bottom of ravines, and separated fro the field where it is to be carried, by a high an steep hill-side. The difficulty of cutting roads i such situations, is much less than any inexpe rienced person would suppose. We cannot g rid of any of the actual elevation—but the ascer may be made as gradual as is desired, by a prop location of the road. The intended course mu be laid off by the eye, and the upper side of th road marked. If it passes through woods, it w be necessary to use grubbing hoes for the diggin With these, begin at the distance of four or fi feet below the marked line, and dig horizontall onward to it. That earth is to be pulled back wit broad hoes, and laid over a width of three or fo feet below the place from which it was take




Thus the upper side of the road is formed by cu ting down, and the lower side by filling up, wi the earth taken from above.

The annexed figure will prevent these directions being misunderstood. The straight line from *a* to *b* represents the original slope of the hill-side of which the whole figure is a section. The upper end of the dotted part of the line is in the mark for laying off the upper side of the road. The upper triangle is a section of the earth dug out of the hill-side, and the lower triangle, of the part formed by its removal. The horizontal line is the level of the road formed by cutting in on the upper, and filling up on the lower side. After shaping the road roughly, the deficiencies will be seen and may be corrected in the finishing work, by deepening some places and filling up others, so as to graduate the whole properly. A width of eight or nine feet of firm road, will be sufficient for carting marl.

If the land through which the road is to be cut is not very steep, and is free from trees and roots, the operation may be made much cheaper by using the plough. The first furrow should be run along the line of the lower side of the intended road, and turned down hill: the plough then returns empty, to carry a second furrow by the first. In this manner it proceeds—cutting deeply, and throwing the slices far, (both of which are easily done on a hill-side,) until rather more than the required width is ploughed. The ploughman then begins again over his first furrow, and ploughs the whole over as at first—and this course is repeated perhaps once or twice more, until enough earth is cut from the upper and put on the lower side of the road. After the first ploughing, broad hoes should aid and complete the work, by pulling down the earth from the high to the low side, and particularly in those places where the hill-side is steepest. After the proper shape is given, carts, at first empty, and then with light loads, should be driven over every part of the surface of the road, until it is firm. If a heavy rain should fall before it has been thus trodden, the road would be rendered useless for a considerable time.

Tumbril carts drawn by a single horse or mule, are most convenient for conveying marl short distances. Every part of the cart should be light, and the body should be so small as only to hold the load it is intended to carry, without a tail-board. This plan enables the drivers to measure every load, which advantage will be found on trial much more important than would at first be supposed. If carts of common size are used, the careless laborers will generally load too lightly—yet sometimes will injure the horse by putting in a load much too heavy. The small-sized cart-bodies prevent both these faults. The load cannot be made much too heavy—and if too light, the farmer can detect it at a glance. Where there is a hill to ascend, five heaped bushels of wet marl is a sufficient load for a horse. If the marl is dry, or the road level, six bushels may be put in the same carts, by using tail-boards.

Strong laborers are required in the pit for digging and loading: but boys who are too small for any other regular farm labor, are sufficient to drive the carts. Horses or mules kept at this work soon become so tractable, that very little strength or skill is required to drive them.

All these hints and expedients, or perhaps better plans, would occur to most persons before they are long engaged in marling. Still these directions may help to smooth the obstructions in the way of the inexperienced—and they will not be entirely useless, if they serve to prevent even small losses of time and labor.

My task is at last completed. Whether I shall be able to pursuade my countrymen to prize the treasures, and seize the profits which are within their reach, or whether my testimony and arguments shall be fruitless, soon or late, a time must arrive when my expectations will be realized. The use of calcareous manures is destined to change a large portion of the soil of Lower Virginia from barrenness to fertility—which, added to the advantages we already possess—our navigable waters and convenient markets, the facility of tilling our lands, and the choice of crops offered by our climate—will all concur to increase ten-fold the present value of our land, and produce more farming profit than has been found elsewhere on soils far more favored by nature. Population, wealth, and learning, will keep pace with the improvement of the soil—and we, or our children, will have reason to rejoice, not only as farmers, but as Virginians, and as patriots.

# APPENDIX.

## *Part III.*

Most of the articles which will be given in this Appendix, are deemed important to the parts of the Essay to which they refer, as furnishing more full explanation, or proof, of positions there maintained: but they are not absolutely essential to the text—and have therefore been thrown into this place and form, both for convenient reference, and to avoid interrupting the train of argument, or the connexion of facts, to those readers who may not need views so extended. But, though a regular recurrence to these notes may not be necessary as they are referred to in the foregoing text—and generally had better be postponed for an after and separate reading—still it is believed that most of them will be found either useful or interesting to those who may have read with approbation what precedes them. This form will be convenient both to those who may choose to pass over, as superfluous, any particular portions, and and to attract to these notes the attention of other readers, who may want the more full statements and proofs offered.

### [NOTE A. Page 9.]

#### THE DIFFERENT IMPROPER SIGNIFICATIONS OF THE TERM "CALCAREOUS EARTH."

The definition of calcareous earth, which confines that term to the carbonate of lime, is certainly liable to objections, but less so than any other mode of arrangement. It may at first seem absurd to consider as one of the three principal earths which compose soils, *one* only of the many combinations of lime, rather than either pure lime alone, or lime in all its combinations. One or the other of these significations is adopted by the highest authorities, when the calcareous ingredients of soils are described—and in either sense, the use of this term is more conformable with scientific arrangement, than mine. Yet much inconvenience is caused by thus applying the term calcareous earth. If applied to *lime*, it is to a substance which is never found existing naturally, and which will always be considered by most persons as the product of the artificial process of calcination, and as having no more part in the composition of natural soils, than the manures obtained from oil-cake, or pounded bones. It is equally improper to include under the same general term all the combinations of lime with the fifty or sixty various acids. Two of these, the sulphate, and the phosphate of lime, are known as valuable manures; but they exist naturally in soils in such minute quantities, and so rarely, as not to deserve to be considered as important ingredients. A subsequent part of this essay will show why the oxalate of lime is also supposed to be highly valuabl as a manure, and far more abundant. Man other salts of lime are known to chemists: bu their several qualities, as affecting soils, are entire ly unknown—and their quantities are too smal and their presence too rare, to require considera tion. If all the numerous different combination of lime, having perhaps as many various and un known properties, had not been excluded by m definition of calcareous earth, continual exception would have been necessary, to avoid stating wha was not meant. The *carbonate of lime*, to whic I have confined that term, though only one o many existing combinations, yet in quantity an in importance, as an ingredient of soils, as well a a part of the known portion of the globe, very fa exceeds all the others.

But even if calcareous earth, as defined an limited, is admitted to be the substance which it i proper to consider as one of the three earths o agriculture, still there are objections to its name which I would gladly avoid. However strictl defined, many readers will attach to terms suc meanings as they had previously understood: an the word calcareous has been so loosely, and s differently applied in common language, and i agriculture, that much confusion may attend it use. Any thing "partaking of the nature of lime" is "calcareous," according to Walker's Dictionary Lord Kames limits the term to *pure lime**—Davy† and Sinclair,‡ include under it pure lime and a its combinations—and Kirwan,|| Rozier,¶ an Young,§ whose example I have followed, confin the name calcareous earth to the carbonate o lime. Nor can any other term be substitute without producing other difficulties. *Carbonate o lime* would be precise, and it means exactly th same chemical substance: but there are insupera ble objections to the frequent use of chemica names in a work addressed to ordinary readers Chalk, or shells, or mild lime, (or what had bee quicklime, but which from exposure to the air, ha again become carbonated,) all these are the sam chemical substance—but none of these name would serve, because each would be supposed t mean such certain form or appearance of calca reous earth, as they usually express. If I coul hope to revive an obsolete term, and with som

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*Gentleman Farmer, page 264, (2d Edin. Ed.)

†Agr. Chem. page 223, (Phil. Ed. of 1821.)

‡Code of Agriculture, page 134, (Hartford E 1818.)

||Kirwan on Manures, Chap. 1.

¶"*Terres*"—Cours Complet d'Agriculture Pratique.

§Young's Essay on Manures, Chap. 3.

modification establish its use for this purpose, I would call this earth *calx*—and from it derive *calxing*, to signify the application of calcareous earth, in any form, as manure. A general and definite term for this operation is much wanting. Liming, marling, applying drawn ashes, or the rubbish of old buildings, chalk, or limestone gravel—all these operations are in part, and some of them entirely, that manuring that I would thus call *calxing*. But because their names are different, so are their effects generally considered—not only in those respects where differences really exist, but in those where they are precisely alike.

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## [NOTE B. Page 11.]

### THE NAMES GIVEN TO SOILS BY WRITERS ON AGRICULTURE OFTEN INCORRECT AND CONTRADICTORY.

Nothing is more wanting in the science of agriculture, than a correct nomenclature of soils, by which the characters might be learned from the names—and nothing has hitherto seemed less attainable. The modes of classing and naming soils, used by scientific authors, are not only different, and opposed to each other—but each one of them is quite unfit to serve the purpose intended. As to the crowd of inferior writers, it is enough to say that their terms are not fixed by any rule—convey no precise meaning, and are worth not much more than those in common use among ourselves, and other practical cultivators, which often vary in their meaning within forty miles of distance. To enable us to judge of the fitness of the names given to soils by others, let us examine those applied by ourselves. We generally describe soils by making a mental comparison with those we are most accustomed to; and though such a description is understood well enough through a particular district, it may have quite a different meaning elsewhere. What are called *clay* or *stiff* soils in Sussex and Southampton, would be considered *sandy* or *light* soils in Goochland—merely because almost every acre of land in the former counties is sandy, and in the latter, clays are nearly as abundant.

The conflict of definitions, and consequent confusion of terms, cannot be more plainly set forth, than by quoting from some of the highest authorities, the various and contradictory explanations of a term, which is so common, that it is used by every one who writes or speaks of soils—and which, in some one or other sense, each writer probably considered as forming a very large, if not the greatest proportion of the cultivated soils of his country, and of the world.

"*Loam* denotes any soil moderately cohesive, " and more so than loose chalk. By the author of " the Body of Agriculture, it is said to be *a clay* " *mixed with sand*." [*Kirwan on Manures—Chap.* 1.]

"*Loam*, or that species of *artificial soil*, into which " the others are generally brought by the course " of long cultivation."—"Where a soil is mode- " rately cohesive, less tenacious than clay, and " more so than sand, it is known by the name of " loam. From its frequency, there is reason to " suppose that *in some cases* it might be called an " *original soil*." [*Sinclair's Code of Agriculture—Chap.* 1.]

"The word loam should be limited to soils con- " taining at least one-third of impalpable earthy " matter, *copiously effervescing with acids*." [*Davy's Agricultural Chemistry—Lecture* 4.] According to this definition by the most scientific writer and highest authority in chemical agriculture, if we except the small portion of shelly land, there is certainly not an acre of *natural loam* between the sea coast of Virginia and the Blue Ridge Mountains—and very few, if any, even in the limestone region.

"By loam is meant *any of the earths combined* " *with decayed animal or vegetable matter*." [*Appendix to Agr. Chem. by George Sinclair*.]

"Loam—*fat unctuous earth—marl*." [*Johnson's Dictionary*, 8vo. *Ed., and also Walker's*.]

"Loam may be considered a clay of loose or " friable consistency, mixed with *mica* or isinglass, " and *iron ochre*." [*Editor of American Farmer, Vol. III, page* 320.]

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## [NOTE C. Page 13.]

### SOME OF THE EFFECTS OF SLAVERY ON AGRICULTURAL PROFITS.

The cultivators of Eastern Virginia derive a portion of their income from a source quite distinct from their tillage—and which, though it often forces them to persist in their profitless farming, yet also, in some measure, conceals, and is generally supposed to compensate for its losses. This source of income is, the breeding and selling of slaves—of which, (though the discussion of this point will not be undertaken here,) I cannot concur in the general opinion that it is also a source of profit.

It is not meant to convey the idea that any person undertakes as a regular business the breeding of slaves with a view to their sale: but whether it is intended or not, all of us, without exception, are acting some part in aid of a general system, which taken altogether, is precisely what I have named. No man is so inhuman as to breed and raise slaves, to sell off a certain proportion regularly, as a western drover does with his herds of cattle. But sooner or later the general result is the same. Sales may be made voluntarily, or by the sheriff—they may be met by the first owner, or delayed until the succession of his heirs—or the misfortune of being sold may fall on one parcel of slaves, instead of another: but all these are but different ways of arriving at the same general and inevitable result. With plenty of wholesome, though coarse food, and under such mild treatment as our slaves usually experience, they have every inducement and facility to increase their numbers with all possible rapidity, without any opposing check, either prudential, moral, or physical. These several checks to the increase of population operate more or less on all free persons, whether rich or poor—and slaves, situated as ours are, perhaps are placed in the only possible circumstances, in which no restraint whatever prevents the propagation and increase of the race. From the general existence of this state of circumstances, the particular effects may be naturally deduced: and facts completely accord with what those circumstances promise. A gang of slaves on a farm will often in-

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crease to four times their original number, in thirty or forty years. If a farmer is only able to feed and maintain his slaves, their increase in value may double the whole of his capital originally vested in farming, before he closes the term of an ordinary life. But few farms are able to support this increasing expense, and also furnish the necessary supplies to the family of the owner—whence very many owners of large estates in lands and negroes, are throughout their lives too poor to enjoy the comforts of wealth, or to encounter the expenses necessary to improve their unprofitable farming. A man so situated, may be said to be a slave to his own slaves. If the owner is industrious and frugal, he may be able to support the increasing number of his slaves, and to bequeath them undiminished to his children. But the income of few persons increases as fast as their slaves—and if not, the consequence must be, that some of them will be sold, that the others may be supported; and the sale of more is perhaps afterwards compelled, to pay debts incurred in striving to put off that dreaded alternative. The slave first almost starves his master, and at last, is eaten by him—at least he is exchanged for his value in food. The sale of slaves is always a severe trial to their owner. Obstacles are opposed to it, not only by sentiments of humanity, and of regard for those who have passed their lives in his service—but every feeling he has of false shame comes to aid; and such sales are generally postponed, until compelled by creditors, and are carried into effect by the sheriff, or by the administrator of the debtor. But when the sale finally takes place, its magnitude makes up for all previous delays. Do what we will, the surplus slaves *must* be sent out of a country which is not able to feed them: and these causes continue to supply the immense numbers that are annually sold and carried away from Lower Virginia, without even producing the political benefit of lessening the actual number remaining. Nothing can check this forced emigration of blacks, and the voluntary emigration of whites, except increased production of food, obtained by enriching our lands, and the consequent increase of farming profits. No effect will more certainly follow its cause than this—that whenever our land is so improved as to produce double its present supply of food, it will also have, and will retain, double its present amount of population. The improving farmer who adds one hundred bushels of corn to the previous product of his country, effectually adds also to its population, as many persons as his increase of product will feed.

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## [NOTE D. Page 17.]

### OPINIONS THAT SOILS ARE GENERALLY CALCAREOUS.

It was asserted that the inference to be drawn from all the descriptions of soils, in the most esteemed treatises on agriculture, is that *calcareous earth* is a very general, if not a universal ingredient. This assertion can be proved beyond all doubt, from European authors: but it would require many and long extracts, too bulky to include here, and which cannot be fairly abridged, or exhibited by a few examples. No author says directly that calcareous earth is present in all soils—but its being always named as one of the ingredients of soils in general, and no cases of its absolute deficiency being directly stated, amount to the declaration that calcareous earth is very rarely, if ever entirely wanting in any soil. We may find enough directions to apply calcareous manures to soils that are deficient in that ingredient: but that deficiency seems to be not spoken of as *absolute*, but *relative* to other soils more abundantly supplied. In the same manner, they direct clay, or sand, to be used as manure for soils very deficient in one or the other of those earths—but without meaning that any soil under cultivation, can be found entirely destitute of sand, or of clay. My proofs from general treatises, would therefore be generally indirect—and the quotations necessary to exhibit them would show what had *not* been said, rather than what *had*—that they did *not* assert the absence of calcareous earth, instead of directly asserting its universal presence. Extracts for this purpose, however satisfactory, would necessarily be too voluminous, and it is well that they can be dispensed with. Better proof, because it is direct, and more concise, will be furnished by quoting the opinions of a few agriculturists of our own country, who were extensively acquainted with European authors, and have evidently drawn their opinions from those sources. These quotations will not only show conclusively, that their authors consider the received European doctrine to be that all soils are more or less calcareous—but also, that they apply the same general character to the soils of the United States, without expressing a doubt or naming an exception.

1st. From a "Treatise on Agriculture," (ascribed to General Armstrong,) published in the American Farmer. [*Vol. I. page* 153.]

"Of six or eight substances, which chemists "have denominated earths, four are *widely and* "*abundantly diffused*, and form the crust of our "globe. These are silica, alumina, lime, and "magnesia."—"In a pure or isolated state, these "earths are wholly unproductive; but when de"composed and mixed, and to this mixture is "added the residuum of dead animal or vegetable "matter, they become fertile, and take the ge"neral name of soils, and are again denominated "after the earth that most abounds in their com"position respectively.—"

2. Address of R. H. Rose to the Agricultural Society of Susquehanna. [*Am. Far. Vol. II. p.* 101.]

"Geologists suppose our earth to have been "masses of rock of various kinds, but principally "silicious, aluminous, calcareous, and magnesian "—from the gradual attrition, decay, and *mixture* "of which, together with an addition of vege"table and animal matter, is formed the soil; and "this is called sandy, clayey, calcareous, or mag"nesian, according as the particular primitive ma"terial preponderates in its formation."

3. Address of Robert Smith to the Maryland Agricultural Society. [*Am. Far. Vol. III. p.* 228.]

"———The soils *of our country* are in general "clay, sand, gravel, clayey loam, sandy loam, "and gravelly loam. Clay, sand, and gravel, "need no description, &c."—"*Clayey loam* is a "compound soil, consisting of clay, and sand or "gravel, with a mixture of *calcareous matter*, and "in which clay is predominant. *Sandy, or gra-*

*velly loam*, is a compound soil, consisting of sand or gravel, and clay, with a mixture of *calcareous matter*, and in which sand or gravel is predominant."

The first two extracts merely state the geological theory of the formation of soils, which is received as correct by the most eminent agriculturists of Europe. How far it may be supported or opposed by the actual constitution, and number of ingredients of European soils, is not for me to decide, nor is the consideration necessary to my object. But the adoption of this general theory, by American writers, without excepting American soils, is an indirect, but complete application to them, of the same character and composition. The writer last quoted, states positively that the various loams, (which comprise at least nineteen-twentieths of *our* soils, and I presume also of the soils of Maryland,) contain calcareous matter. The expression of this opinion by Mr. Smith, is sufficient to prove that such was the fair and plain deduction from his general reading on agriculture, from which source only could his opinions have been derived. If the soils of Maryland are not very unlike those of Virginia, I will venture to assert, that not one in a thousand of all the clayey, sandy, and gravelly loams, contains the smallest proportion of *carbonate of lime*—and that not a single specimen of calcareous soil can be found, between the falls of the rivers, and the most eastern body of limestone.

But though the direct testimony of European authors, (as cited in the essay,) concurs with the indirect proofs referred to in this note, to induce the belief that soils are very rarely destitute of calcareous earth, yet statements may be found of some particular soils being considered of that character. These statements, even if presented by the authors of general treatises, would only seem to present exceptions to their general rule of the almost universal diffusion of calcareous earth in soil. But so far as I know, no such exceptions are named in the descriptions of soils in any general treatise, and therefore have not the slightest effect in contradicting or modifying their testimony on this subject. It is in the description of soils of particular farms, or districts, that some such statements are made: and even if no such examples had been mentioned, they would not have been needed to prove the existence, in Europe, of some soils like most of ours, destitute of calcareous earth. These facts do not oppose my argument. I have not asserted, (nor believed, since I have endeavored to investigate this subject,) that there were not soils, and perhaps many extensive districts, containing no calcareous earth. My argument merely maintains that these facts would not be inferred, but the contrary, by any general and cursory reader of the agricultural treatises of Europe, that we are best acquainted with. It has not been my purpose to inquire as to the existence, or extent, of soils of this kind in Europe. But judging from the indirect testimony furnished by accounts of the mineral and vegetable productions in general descriptions of different countries, I would suppose that soils having no calcareous earth were often found in Scotland and the northern part of Germany, and that they were comparatively rare in England and France.

## [NOTE E. Page 18.]

### DIRECTIONS FOR ANALYZING MARL, AND OTHER CALCAREOUS SUBSTANCES.

It is unnecessary here to describe Professor Davy's apparatus for measuring the carbonic acid gas evolved from any given quantity of calcareous soil, (and of course of marl,) and thus ascertaining the proportion of the carbonate of lime contained. Without a plate, the description could not be made plain—and the expense of the apparatus would be a sufficient prohibition of the purchase to every reader who cannot easily refer to the original description in the *Elements of Agricultural Chemistry*.

Prof. W. B. Rogers, has recently invented, and has used successfully, a much cheaper apparatus, and which for trials of very small quantities of marl, is also much more correct. His description of this apparatus will be copied from the Farmers' Register, Vol. II. p. 364.

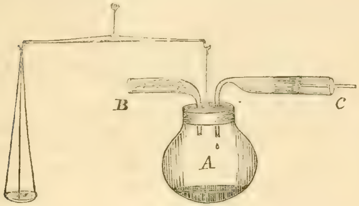
"The apparatus which I am about to describe, is intended to give greater accuracy and facility to the usual process for determining the quantity of carbonic acid in marl, or in any of the carbonates. By the common method, the two vessels containing severally the marl and the muriatic acid are placed in one of the scales of a delicate balance, and there counterpoised by weights put into the other scale. The acid is then poured upon the marl, and after all the carbonic acid has been discharged, the equilibrium is restored by adding weights to one, or abstracting them from the other scale. In principle, this method is entirely free from objection: but as usually conducted, it cannot be relied upon as accurate. This want of precision arises, in the first place, from the escape of aqueous vapor, along with the carbonic acid which is discharged, thus making a greater weight necessary for restoring the equilibrium, than is due to the quantity of carbonic acid which has escaped —and secondly, from the greater weight of the vessels containing the marl and acid impairing the sensibility of the balance, and thus rendering it impossible to estimate the carbonic acid to small fractions of a grain. The first of these objections has long been obviated in the chemical analysis of the carbonates, by causing the gas, as it escapes, to pass through a tube containing dried muriate of lime; and the latter has been in some measure removed, by a contrivance of the great practical chemist Rose; which, however, as it is inconvenient and uncertain in the manipulation, I shall not here describe.

"The apparatus which I have devised, is, I think, free from these objections, and enables the operator to proceed with great accuracy and despatch. It has the advantage of being very easily constructed, and of being used with a balance that can be procured at a very moderate price. Moreover, the quantity of marl which is necessary for experiment in no case exceeding ten grains, specimens for analysis may very easily be forwarded by letter.

"The balance which I use with this apparatus, is a small goldsmith's balance—such as may be procured for a few dollars in New York. It is very light, and turns, when unloaded, with the $\frac{1}{100}$th of a grain. My set of weights obtained from Mil-

lington in Philadelphia, extends to tenths and hundredths of the grain.

"The accompanying figure will convey a distinct idea of the apparatus and mode of using it. One of the scales is removed to admit of suspending the apparatus by a double thread over the hook of the beam. The other is made of something light, as a piece of card. In this way all unnecessary weight upon the beam is avoided, and its sensibility preserved.




"A, is a light bulb of glass, blown very thin from a common piece of tube, and about one inch in diameter. A cork is fitted to its mouth, and through this, the tapered ends of the bent glass tubes, B and C, are passed air tight; the extremity of the latter extending some distance into the vessel. The tube B, through which the gas escapes, is filled with fragments of muriate of lime. The tube C, which contains the muriatic acid, is furnished with a light piston of cork or cotton, in the centre of which is fixed a rod or handle, made of a small stiff straw. This instrument, when charged with marl and acid, does not weigh more than 120 grains. The whole load of the beam is therefore 240 grains, and it is still sensible to the $\frac{1}{100}$th of a grain.

"The mode of proceeding with the analysis is as follows. Five or ten grains of the finely powdered marl is introduced into the vessel A, and then two or three drops of water added, to assist the diffusion of the acid. The small end of the tube C, now removed from the cork, is dipped into some muriatic acid in a wine glass, and the piston moved backwards and forwards until the necessary quantity of acid has been drawn in. The tube is then replaced in the cork, and in this state the instrument is counterpoised by weights in the opposite scale. The piston being then gradually forced in, the acid is injected, drop by drop, upon the marl, and the gas escapes by the tube B, depositing the aqueous vapor in its passage, on the muriate of lime. Allowing the apparatus to rest until the gas has entirely escaped, and the decomposition is complete, the equilibrium is restored by placing weights upon the clear top of the cork, or by removing weights from the scale. In this way the weight of the disengaged gas is accurately determined, and the proportion of carbonate of lime thence computed.

"An analysis of a specimen of marl from James City, just completed, will serve as an illustration of the method. Ten grains of the finely powdered marl was introduced with a little water into the vessel A, the instrument was then charged and equipoised. The acid being injected, the whole was allowed to rest for an hour. The weight lost was 2.91 grains. Increasing this in the ratio of 44 to 100, gives 6.61 grains of carbonate of lime in the 10 grains of marl—or almost precisely 66 per cent.

"The frequent calls upon me for the analysis of specimens of marl, first led me to the construction of this apparatus; and I have since found it so convenient and accurate, that I can recommend its adoption to such of your readers as may have a taste for chemical inquiries connected with agriculture. Any ordinary worker in glass will construct the instrument, and skill in manipulating with it may be soon and easily acquired.

WM. B. ROGERS."

The principle upon which the apparatus works is the same as that of the more expensive and complicated apparatus of Davy, (described in his *Agricultural Chemistry)* which I had previously considered the best—that is by separating and ascertaining the weight of the carbonic acid combined with the lime of the manure. Every hundred grains of calcareous earth or carbonate of lime, is composed always of similar proportions of lime and of carbonic acid—which proportions, by weight, are 56 parts of lime, and 44 of carbonic acid. Of course, if we know how much weight is lost in 100 grains of earth partly of carbonate of lime, (as marl,) by driving off its carbonic acid, the rule of proportion will show what was the amount of carbonate of lime contained in the sample of earth.

When the muriatic acid reaches the earth in the bulb, it immediately combines with the lime by its greater attraction, and the weaker (carbonic) acid is disengaged in the form of gas, and escapes into the air through the tube containing the dry muriate of lime—which substance attracts moisture so powerfully, as to retain all that might otherwise pass out with the gas. The same muriate of lime will serve for many experiments, if by being heated in the tube, its dryness is restored previous to every trial. This salt is formed by the combination of muriatic acid with lime—and therefore every experimenter may provide it for himself by filtering and evaporating the fluid left in the process of decomposing carbonate of lime.

Mr. Rogers has since informed me that a small portion of dry and lightly carded cotton will serve as well as the muriate of lime for arresting the moisture.

The mode of analyzing by solution and precipitation, though not to be trusted for operations where great exactness is required, and although much more troublesome than the using of either Davy's or Rogers' apparatus, is sufficiently correct for testing the strength of marl: and it has the advantage of requiring no apparatus, except a glass funnel, some blotting paper, and a set of small physic scales and weights—and no other tests than muriatic acid and carbonate of potash—all of which may be obtained at any apothecary's shop. The directions which follow, will be given with so much minuteness, that any attentive reader may both understand and follow them in practice, though totally unacquainted previously with chemical terms and processes. These directions also first appeared in the Farmers' Register, Vol. I. p. 609.

"1st. Take a lump of marl, fossil shells, &c. large enough to furnish a fair sample of the particular body under consideration—dry it perfectly near the fire—pound the whole to a coarse powder (in a metal mortar,) and mix the whole t

ther. Take from the mixture a small sample, hich reduce to a finely divided state, and weigh it a certain portion, say 50 grains, for trial.

2nd. To this known quantity in a glass, pour owly and at different times, muriatic acid diluted ith three or four times its bulk of water—(any cept limestone, or *hard* water.) The acid ill dissolve all the lime in the calcareous earth, nd let loose the carbonic acid with which it was eviously combined, in the form of gas, or air, hich causes the effervescence, which so plainly arks the progress of such solution. The addi- on of the muriatic acid, must be continued as ng as it produces effervescence; and but very tle, after that effect has ceased. The mixture ould be well and often stirred, and should have ough excess of acid to be sour after standing irty or forty minutes. (So much of the acid as e lime combines with, loses its sour taste, as ell as its other peculiar qualities.)

3rd. The mixture now consists of 1. the lime ombined chemically with muriatic acid, forming *uriate of lime*, which is a *salt*, and which is dis- olved in the water—2. a small excess of muriatic cid, mixed with the fluid—and 3. the sand, clay nd any other insoluble parts of the sample of arl. To separate the solid from the fluid and oluble parts, is the next step required.

Take a piece of filtering or blotting paper, bout six or eight inches square, (some spongy nd unsized newspapers serve well,) fold it so as o fit within a glass funnel, which will act better f its inner surface is fluted. Pour water first into he filter, so as to see whether it is free from any ole, or defect—if the filtering paper operates well, hrow out the water, and pour into it the whole nixture. The fluid will slowly pass through into a glass under the funnel, leaving on the filter all he solid parts, on which, water must be poured nce or twice, so as to wash out, and convey to he solution, every remaining particle of the dis- solved lime.

4th. The solid matter left, after being thus washed, must be taken out of the funnel on the paper, and carefully and thoroughly dried—then scraped off the paper and weighed. The weight, say 27 grains, being deducted from the original quantity, 50, would make the part dissolved (50—27=23,) $\frac{46}{100}$ of the whole. And such may be taken as very nearly the proportion of calcareous earth (or carbonate of lime) in the compound examined. But as there will necessarily be some loss in the process, and every grain taken from the solid parts, appears in the result as a grain added to the carbonate of lime, it will be right in such partial trials to allow about two per cent. for loss, which allowance will reduce the foregoing statement to $\frac{44}{100}$ of carbonate of lime.

5th. But it is not necessary to rely altogether on the estimate obtained by subtraction, as it may be proved by comparison with the next step of the process. Into the solution (and the washings) which passed through the filter, pour gradually a solution of *carbonate of potash*, (salts of tartar.) The first effect of the alkaline substance thus added, will be to take up any excess of muriatic acid in the fluid—and next, to precipitate the lime (now converted again to carbonate of lime,) in a thick curd-like form. When the precipitation is ended, and the fluid retains a strong taste of the carbonate of potash, (showing it to remain in excess,) the whole must be poured on another filtering paper, and (as before,) the solid matter repeatedly washed by pouring on water, then dried, scraped off, and weighed. This will be the actual proportion of the calcareous part of the sample, except, perhaps a loss of one or two grains in the hundred. The loss, therefore, in this part of the process apparently lessens, as the loss in the earlier part increases the statement of the strength of the manure. The whole may be supposed to stand thus—

$$\left.\begin{array}{l}\text{27 grains of sand and clay.}\\ \text{21 ——— of carbonate of lime.}\\ \text{2 ——— of loss.}\end{array}\right\} = 50.$$

If the loss be divided between the carbonate of lime and the other worthless parts of the manure, it will make the proportions 28 and 22, which will be probably near the actual proportions.

The foregoing method is not the most exact, but is sufficiently so, for practical use. All the errors to which it is liable, will not much affect the reported result—unless magnesia is present, and that is not often in manures of this nature. Magnesia is never found (I believe,) in the collections of fossil shells—nor have I known of its presence in any of the earthy manures, except limestone, and the magnesian marl lately discovered in Hanover. If any considerable proportion of carbonate of magnesia should be present in marl tried by the foregoing method, it may be suspected by the effervescence being very slow, compared to that of carbonate of lime alone: and the proportions of these two earths may be ascertained as follows. The magnesia as well as the lime would be dissolved by the muriatic acid, (applied as above directed,) but the magnesia would not be precipitated with the carbonate of lime, but would remain dissolved in the alkaline solution, last separated by filtering. If this liquor is poured into a Florence flask, and boiled for a quarter of an hour, the carbonate of magnesia will fall to the bottom, and may then be separated by filtering and washing, and its quantity ascertained, by being dried and weighed. This part of the process may be easily added to the foregoing—but it will very rarely be required."

If desired, the proportions of silicious and aluminous earth may be ascertained, with enough truth for practical use, by stirring well these parts (minutely divided,) in a glass of water, and after letting it stand a minute, for the sand to subside, pouring off the fluid into another glass. The sand will be left, and the aluminous earth, or pure clay, pass off with the water—and each may be collected and dried on filtering paper, and weighed.

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## [NOTE F. Page 27.]

### PROOFS OF THE EXISTENCE OF ACID SOILS, FURNISHED BY THE RECENT RESEARCHES OF CHEMISTS.

The *Traité de Chimie* is a French translation by Esslinger, of the voluminous and valuable work of the great Swedish chemist Berzelius. The original work and the French translation were in the course of publication at the same time; and the first volumes of the latter were published at Paris, before the latter volumes of the original

work had been sent to the press at Stockholm. The sixth volume of the French translation, from which the following extract is translated into English, was printed in 1832. It is not known whether the original work is in this country.

The following passages contain the opinions of Berzelius, and of other chemists, on humin, and humic acids, or as called here, *geine* and *geic acid*, and which were referred to in the quotation from Rennie, at page 28. It will be left to the reader to decide, how far my views of acid soils are supported by these opinions of chemists, founded upon chemical analyses of the substances in question. It is proper to state, that this new doctrine of geic or humic acid has not passed uncontroverted. It is altogether denied by Raspail, a French chemist, and who is a later writer than Berzelius.

Extracts translated from the *Traite de Chimie*.

PRODUCTS OF PUTREFACTION AT THE SURFACE OF THE EARTH.

*Mould* [terreau.]

The vegetable matters which rot at the surface of the earth, finish by leaving a blackish brown pulverulent mass, which has received the name of *mould*, [humus.]

All the vegetation of a year, which dies at the arrival of winter, is converted by degrees to mould, which is mixed with the earth in which the plant grew: whence it comes that the extreme surface of the earth contains a greater or less proportion of mould, which serves for the nutriment of the succeeding growth of plants. This mould, such as it is found in the earth, is often mingled with the products of a less advanced putrefaction, or even with vegetable parts not changed, principally, a great quantity of small roots. If we examine the mould, such as it is found in cultivated soils, it is found to be in a mass very much mixed; but it is always possible to extract the parts which characterize mould.

During the transformation of the vegetable matters to mould, the first portion of their mass is changed into a brownish black substance, which presents all the characters of *apotheme*,* when we have separated from it the unaltered *extract*, which the apotheme draws with it. The salts of such acids as are of organic origin, contained in the vegetable matter, are destroyed, so that the elements of the acid are resolved into water and carbonic acid, whilst the base is combined with the substance analogous to apotheme, which makes part of the mould. The salts of acids of mineral origin are preserved, unless they are soluble, in which case the rain carries them off. In addition, mould contains a substance but slightly soluble in water, which colors the liquid yellow, and a carbonaceous substance which is entirely insoluble, and which appears to be one of the products of a destruction, still more advanced, of organic matters.

To give an example of a completed formation of a mould of vegetable origin, I shall here state the results of an analysis to which Bracannot submitted some wheat, which had remained during many centuries in a damp vault, the issues from which were stopped up by earth, and of which the existence was forgotten, until by chance it was again discovered. The grains had preserved their form, and the brightness of their outside skin; but they were black, and were reduced by the slightest pressure to a black powder. The water with which they were boiled was colored yellow, and it left, after being evaporated, a saline mass of a brownish yellow, which burnt with slight explosion when heated, and which, besides the substance cited, soluble in water, contained nitrate of potash, nitrate of lime, and a little of the muriate of potash and of lime. The nitrates were the result of the oxydation of the nitrogen contained in the gluten and vegetable albumen, and of the combination of the nitric acid thus produced, with the bases previously combined with vegetable acids. The weight of this mass soluble in water, including the salts and all the other principles, did not exceed $1\frac{1}{2}$ per cent. of the weight of the black grain. When the part insoluble in water was boiled in alcohol, a small trace of a brown substance was taken up, which remained after evaporating the alcohol, and had the consistence of wax. The mass, exhausted of its soluble parts by boiling water and alcohol, was then heated slowly with a weak solution of caustic potash, which became saturated and colored of a blackish brown, and this treatment was continued as long as new potash lie took up any thing. This substance was precipitated from the solution by an acid: it was the body similar to *apotheme* which has already been mentioned, and of which the weight amounted to $26\frac{1}{2}$ per cent. The portion of matter insoluble in the alkali preserved the same appearance. This exposed to the action of diluted muriatic acid, yielded to it a certain quantity of lime, of oxide of iron, and of phosphate of lime. The residue was again acted on by potash, which took up a new and very large proportion of the body similar to *apotheme*. This was, after that, combined with lime, and resisted in that state the action of potash. This calcareous combination amounted to 42 hundredths. The 30 per cent. remaining consisted of a black carbonaceous matter, insoluble in the solvent used.

If cultivated soil is treated in the same manner, similar results will be obtained, with this difference, that the earthy matter of the soil is found mixed with the products which are obtained, whilst no soluble salts are met with, they being generally carried off by the rains.

To describe the constituent principles of mould, it is necessary to designate them by particular names. I will then call *extract of mould* the body soluble in water, and I will give the name of *geine** to the matter similar to apotheme, which constitutes the principal mass of mould. As to the coally substance insoluble in water, alcohol, acids and alkalis, I will designate it by the name of *carbonaceous* mould.

*Extract of mould.*

We obtain this substance by drawing it from the mould by the action of cold water, which becomes thereby colored yellow, and which leaves after evaporation, a yellow extract of a bitter taste, and from which some geine is separated when it

* What Berzelius calls apotheme, is "a deposite slightly soluble in water, produced in an aqueous solution of vegetable extract during slow evaporation, and containing a larger proportion of carbon, than does an equal weight of extract."

*Or *humin*, as termed by other authors.

ıgain acted on by water. If this solution is , to evaporate spontaneously, in contact with it becomes covered with an insoluble pellicle, l when a certain degree of concentration has n reached, the liquor becomes turbid. The ıtion is precipitated by the salts of tin and of l: after the precipitation, the liquor is without or. According to Korte, the sulphuretted hygen gas precipitates it also. This extractive tter is contained in the water of many springs l streams. The water of the springs of Porla Westrogotha, contains so great a quantity that colored yellow. When the iron contained in water is oxydized from the air, the extract of uld is precipitated with the oxide of iron, and water becomes clear.

*Geine.*

This substance has received different names. acannot has given to it the name of *ulmin*, for sons which I have exhibited and opposed in a ner part of this work. Dobereiner and Spren- gave to it the name of *acid of humus*, because ombines with the earths and alkalis. But for same reason we might give the name of *acid* more than the half of all vegetable bodies.

Geine does not exist in vegetable earth only; t contains it also, and according to Bracannot, s formed when the saw-dust of wood is exposed he action of caustic potash. It is almost imsible to obtain geine in a state of purity. One t of the geine which is met with in a natural te, is in combination with bases; but when we empt to remove these by an acid, the geine nbines in part with the excess of acid, and acres itself (in part) the property of reddening getable blues. Geine possesses all the proper- of apotheme, and it is produced like other othemes; that is to say, by the action of the air dissolved extract of mould. In its natural state oes not act chemically, either like the acids or alkalis, nor does it have any effect on the color vegetable blues. It is but slightly soluble in ter, which it colors of a pale yellow; is still less uble in alcohol, and insoluble in ether. Exed to the action of heat it takes fire, burns at t with flame, then without flame like spunk, eading a peculiar odor, something like that of ning peat. Submitted to dry distillation, it is omposed, gives half its weight of a charcoal ving a metallic lustre, of empyreumatic oil, an d water containing acetic acid and sometimes monia, some carburetted hydrogen, and a little bonic acid gas. If geine is held suspended in ter, through which a current of chlorine is pas-, this whitens it, and precipitates a white resin- substance. Iodine is without action on it. we add an acid to an alkaline solution of geine, geine is precipitated. If the whole of the ne is not precipitated, that part which is preitated retains in combination a small portion of base, and leaves, when it is burnt, a small ntity of alkaline ashes. If, on the contrary, excess of acid is poured into the alkaline soluı, the liquor is discolored, and the precipitated ne strongly reddens vegetable blues, a property ich cannot be removed by placing the geine on lter, and pouring water upon it. So long as liquor which passes through the filter contains acid, it is not colored; then it begins to be ored, and finally it dissolves as much as two-thirds of its weight of the precipitated mass. These acid properties belong in part to the geine, which owes them to the action of the alkali, and which may, in this case, be called *geic acid;* they ought to be in part attributed to a combination of the geine with the precipitated acid. According to Einhoff, it is the latter case which is really presented, and the acid cannot be carried off, but with the aid of an alkali. Sprengel, on the other hand, pretends to have freed the geine, by prolonged washing, from the muriatic acid which had served to precipitate it: and to make certain the absence of the muriatic acid, he has mixed the washed geine with a little nitrate of silver. After evaporation to dryness, and calcination, the residue, treated by nitric acid, was dissolved, without leaving any muriate of silver. But as muriate of silver, like the other salts of silver, is reduced to a metallic state by bodies containing carbon and hydrogen, and carbon itself effects the same change when disengaged along with water, this result proves nothing. In general, in the descriptions of geine, they have attributed the properties of that which has been changed by the action of an alkali, to the geine which has not been altered. The geine which reddens vegetable blues, is the same, whatever may have been the acid which served for its precipitation. Its saturated aqueous solution is of a yellowish brown, and the combination is precipitated anew by acids, excepting the carbonic, and the sulphuretted hydrogen. Collected upon a filter, it is presented under the form of a gelatinous mass, of a taste slightly acid, astringent—and by drying, it contracts strongly, and forms clots of a deep brown, almost black, with a vitreous fracture, and which are not dissolved again in water after being once completely dried. The aqueous solution of the acid geine, is precipitated by the salts of lead, of tin, and of iron; but is not disturbed by gelatine, albumen, starch, gum, tannin, or solution of soap. According to Bracannot, it is precipitated by a mixture of the solution of gelatine and gallic acid. The dried geine is dissolved with difficulty, and incompletely, in alcohol. The solution reddens vegetable blues, whilst the part not dissolved is without this power, though it still preserves the property of combining with potash. Geine is destroyed by concentrated acids. The sulphuric acid dissolves it, taking at the same time a black color, carbonizing it, disengaging sulphurous acid gas, and leaving for residue the ordinary products which result from the action of this acid. By the addition of sur-oxide (or black oxide) of manganese, carbonic acid gas is disengaged. The nitric acid dissolves and decomposes geine, with a disengagement of nitric oxide gas, and carbonic acid gas. If the solution is evaporated to the consistence of sirop, and then mixed with water, there is precipitated a peculiar bitter substance in powder, and there are found in the solution, artificial tannin and oxalic acid.

Geine forms soluble combinations with alkalis. When an excess of geine is used, the caustic alkalis are so neutralized by this substance, that they lose their peculiar chemical action and properties. In this respect geine agrees with gluten, vegetable albumen, the brown of indigo, the sugar of liquorice, apotheme, and other bodies not acid. During the evaporation, the solution furnishes a black mass, which acquires lustre by complete drying, and splits, and is easily reduced to a powder. It

is re-dissolved in water, its taste is weak, bitter and disagreeable. Caustic ammonia gives a like mass, soluble in water, which gives up, during evaporation, the excess of alkali employed. Geine is not dissolved always in alkaline carbonates; when it is so dissolved, these carbonates are transformed, half into *geates*, half into bi-carbonates. When the solution is boiled, the bi-carbonate is decomposed with disengagement of carbonic acid gas, and in this manner the geine drives off all the carbonic acid. If a solution of geine in carbonate of ammonia, is evaporated, a residue is obtained containing neutralized geate of ammonia. The solution of geine in caustic potash in excess, absorbs oxygen from the air, and at the end of some time, the alkali is in part carbonated.

Geine forms with the *alkaline earths* pulverulent combinations but little soluble, which have an external resemblance to geine. The best means for obtaining them, is to mix a solution of the geate of ammonia, with the solution of an earthy salt; the combination of the geine with the earth is precipitated, and may be separated by filtration, from the supernatant fluid. In the humid state, these compounds are slightly soluble in water. According to the experiments of Sprengel, one part of *geate of barytes* is dissolved in 5200 parts of water, one part of geate of lime is soluble in 2000 parts of water, and one part of geate of magnesia, in 160 parts of water, cold. These same compounds require for their solution, rather smaller proportions of boiling water. After having been completely dried, they will no more dissolve. In the air, the base is combined in part with carbonic acid, and the carbonate which results therefrom, remains in the state of mixture with a combination of geine, and of a base analogous to a super-salt. The alkaline carbonates decompose the earthy geates; they dissolve the geine, and leave the base in the state of carbonate. According to Sprengel, the *geates of lime* and *magnesia* are dissolved in the caustic fixed alkalis, and in the carbonate of ammonia. Other chemists have not arrived at the same result; and according to them, the geate of potash, acted on by the hydrate of lime, precipitates all the geine. The *geate of alumina* is precipitated when a solution of alum is mixed with a solution of geate of potash, or of ammonia. This compound is dissolved in 4200 parts of cold water. In the moist state it is dissolved easily, and in abundance, in the alkaline carbonates and hydrates, and even in ammonia. According to Sprengel, it resists the decomposing action of acids, so that it is difficult to extract from it geine exempt from alumine. A combination is obtained having an excess of alumine, by digesting a solution of the geate of ammonia with hydrate of alumina. *

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### *Carbonaceous mould.*

The substance to which this name has been given has been but little examined. It is insoluble in alkaline liquors. Its color is a brown, almost black. Placed in contact with a body in combustion, it takes fire, and burns without flame like spunk. According to the experiments of Th. de Saussure, carbonaceous mould combines with the oxygen of the air, and forms carbonic acid gas, and when it is left a long time exposed to air and water, it becomes by slow degrees soluble in alkalis. The acids precipitate it from the alkaline solution, in the state of a[c] geine. When cold, the sulphuric acid has [l] little effect on it. According to Bracannot, t[he] nitric acid converts it, at a gentle heat, to a bro[wn] liquor, in which water produces a precipitate o[f] chocolate color, which possesses the properties acid geine, and is dissolved without residue, in t[he] alkalis.

### *Soil* [terre végétale.]

It is the mixture of these several substan[ces] with the upper layer of the surface of the ear[th] which constitutes the *vegetable earth*, or *soil*, p[ro]perly so called. Arable land is a bed of this s[oil] placed upon a bed of earth which contains mould. Its fertility depends upon the quantity mould which it contains. Growing plants co[n]tinually diminish the quantity of geine contain[ed] in the soil; and when the plants are carried from the soil on which they grew, which happ[ens] almost always with cultivated land, it is fina[lly] exhausted to that degree as to produce nothi[ng]. It is on this account that it is necessary to man[ure] land. The matters discharged and left by anima[ls] or the barn-yard manure which is used for t[his] purpose, are by degrees converted into geine, a[nd] thus replace the matters dissipated by vegetati[on]. Botanists who have directed their attention to [ve]getable physiology, have remarked that the pla[nts] vegetate well enough without geine, until [the] time arrives for them to commence their sex[ual] functions. But as soon as these are ended, a[nd] the fruit begins to be developed, the plants abs[orb] a great quantity of the nutritive principles co[n]tained in the soil, and if these are not in the s[oil] the flower falls without forming any fruit. T[he] experiments to which Th. de Saussure has s[ub]mitted soil, [terre végétale] appear to demonst[rate] that the three constituent principles of mould, m[ay] be converted the one to the other, under [the] alternately preponderating influence of air [and] water. Water converts to the *extract of mou[ld]* part of the insoluble *geine* contained in the soil, this transformation extends more and more, that finally the greater part of the geine beco[mes] soluble. In contact with the air, the dissol[ved] matter passes again to the state of geine. [The] *carbonaceous mould* which changes a part of [the] air into carbonic acid, is itself changed by air [into] geine, and into the extract of mould, and it is u[pon] this transformation that appear to depend in [part] the advantages derived from the tillage of the [soil] which is divided by the action of the plough, exposed to the immediate influence of the air. [In] this manner all the parts of the soil contribut[e to] nutrition; whilst it is probable that the solutio[n of] the extract of mould, that of the geate of li[me] and perhaps also that of the geate of alumine, [are] immediately absorbed by the roots. Durin[g a] heavy rain, this solution penetrates the inte[rior] and often to very deep beds of the steril earth; notwithstanding that, it is not lost to veget[able] life: for the roots of trees seek it, and bring it [back] as matter suitable for their nourishment.

Experience has demonstrated that quickl[ime] and the carbonate of lime, mingled with the [soil] favor the vegetation produced thereon. Chem[istry] has not yet explained, in a satisfactory man[ner] the power which lime thus exerts; however, [it is] known that when the soil contains this alk[aline] earth, or, in its place, ashes only, the moul[d is]

uickly consumed, and vegetation becomes more ch in proportion. It has thence been concluded at lime acts, partly in exciting the plant to great- activity, and partly in rendering more soluble e principles of the soil, which are absorbed by e roots when dissolved in the water which the rth has imbibed. Lime is not then a true [or imentary] manure. It contributes only to pro- ote and hasten the absorption of the principles hich serve to nourish the plant; and that lime ay be serviceable, it is necessary to introduce to the soil, improved by lime, materials proper furnish new quantities of mould. The lime, or e alkali contained in ashes, acts also in hastening e change of organic matters to mould.

It is known by experience, that gypsum also ugments the fertility of the earth, especially when guminous plants are cultivated. It is not proba- le that this neutral salt acts in the same manner s lime, and we are ignorant of what is its mode f acting.

Soil [*terre végétale*] possesses the property of eing able to retain as much as three-fourths of s weight of water without appearing moist, and ke charcoal, it condenses atmospheric humidity. t owes this property to the geine which it con- ins, which is one of the substances which, of all nown, absorbs moisture with most energy. lould [*terreau*] can absorb double its weight of ater, without appearing moist; and after being ried, it draws from the air, in less than twenty- our hours, a quantity of water, which may vary ccording to the humidity of the atmosphere, from 0 to 100 per cent. of its weight. This property epends upon its light and dust-like consistence; nd geine, of which the fracture becomes vitreous om its course of chemical treatment, is deprived f this physical property, which is of the utmost nportance to vegetable life. For, in consequence f this property, mould retains water in the earth nd obstructs its evaporation; and it is probably is water which maintains the extremities of the oots in the state to perform their functions.

It is usual to divide soil into fertile earth, and cid earth.* The first is very common—the se- ond presents itself but rarely. It produces no- hing, unless it be mosses: it is in marshy places hat it is ordinarily found. It is in general com- osed in the same manner as fertile earth; but vhilst in the latter the geine is united with lime, nd perhaps with other bases besides, it is, in the cid earth, combined with acids, which, according o Einhof, are the phosphoric and acetic acids. It s for this reason that it has the property of red- lening vegetable blues, and that it gives, by cal- ination, ashes which contain phosphoric acid. To dry distillation, it yields a great quantity of an acid liquid, containing the acetate of ammonia; and when it is distilled, after having mixed it with water, a liquid product is obtained which reddens vegetable blues, and likewise contains acetate of ammonia. In opposition to Einhof, Sprengel af- firms that the acid geine is produced only for the want of bases, and that its acid action proceeds only from the geic acid which it contains, and not from the presence of a foreign acid. De Pontin has made the analysis of an arid* soil taken from the plain of Eckerud in the government of Elfs- burg in Sweden, and found that the geine had there combined with the malic, acetic, and phos- phoric acids. The dissolving of the soluble prin- ciples of the soil in boiling water, left to be de- posited, when the hydrate of lime was mixed therein, these acids as well as geine, so that there was found afterwards in the water only traces of the acetate and hydrate of lime. But when a current of carbonic acid gas was made to pass through this precipitate steeped in water, the geine remained, without dissolving, in combination with the carbonate of lime produced, while there was formed a solution slightly yellowish, which left, after evaporation, a residue of calcareous salts. This residue was treated by alcohol, which took up a certain quantity of acetate of lime, and left a salt of lime of a gummy appearance, which was soluble in water, and possessed the properties of the malate of lime. In burning the geate of lime, and taking up the residue by muriatic acid, there was obtained a solution which, when treated by ammonia, gave a small precipitate of phosphate of lime. The greater part of the acid geine was dissolved in the carbonate of ammonia. Hydrate of lime was poured into the solution, which pre- cipitated the geine without leaving in solution a salt of lime. But when after having washed the precipitate, it was calcined, and the residue treated with muriatic acid, there was obtained a solution, which, after the expulsion of the carbonic acid, gave with ammonia an abundant precipitate of the phosphate of lime. These experiments con- firm those given by Einhof.

An arid* soil becomes fertile when there is mixed with it lime, or ashes and earth, inasmuch as the soil consists principally of geine. The re- port of Sprengel, according to which, it [this cha- racter of soil] is produced in consequence of the absence of the bases which are found in fertile earth, is certainly true; but it does not follow from that, that it owes its acidity solely to the acid na- ture of the geine. The ashes of arid* soil always contain a great quantity of silex.

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* It is not a little strange to say it is "*usual* [*dans 'usage*] to divide soils into fertile earth and *acid* earth," vhen the acid nature of any, has been treated by Ber- elius as a new discovery, and of which the truth is ot admitted by all of those who had taken the sub- ect into consideration. If this division had indeed een usual, there would have been no want of numer- us authorities (whatever might be their value) for he acidity of soil.

*This is still more strange, that so abrupt a transla- tion should be made from *acid*, to *arid* soils—and in such manner as to induce the belief that the change was not owing to the author—but to an error of the press. But though this mistake would be as likely to occur in French as almost any other, (only one letter be- ing different in the words *acide* and *aride*—) still it is difficult to believe that this same error should have been made and left to stand three times in this and the next page, where "arid" soils are named, and are marked * as above. The French translation is said to contain numerous typographical errors. I leave others to decide whether these are among the number or not.

## [NOTE G. Page 35.]

### THE STATEMENTS OF BRITISH AUTHORS ON MARL, GENERALLY INCORRECT AND CONTRADICTORY.

Custom compels me to apply improperly the name *marl* to our deposites of fossil shells. But as I have defined the manuring by this substance, which is called *marling*, to be simply *making a soil calcareous*, or more so than it was before, any term used for that operation would serve, if its meaning was always kept in view. But this term, unfortunately, is of old and frequent use in English books, with very different meanings. The existence of these differences and errors, has been generally stated in the foregoing pages of this essay, and I shall here present the proofs. The following quotations will show that the term *marl* is frequently applied in Britain, to clays containing no known or certain proportion of calcareous earth—that when calcareous earth is known to be contained, it is seldom relied on as the most valuable part of the manure—and that in many cases *the reader is left in doubt whether the manure has served to increase, or diminish, or has not altered materially, the amount of the former calcareous ingredient of the soil.*

The passages quoted will exhibit so fully the striking contradictions and ignorance generally prevailing as to the nature and operation of marl, that it will scarcely be necessary for me to express dissent in every case, or to point out the errors or uncertainty of facts, or of reasoning, which will so abundantly appear.

1. Kirwan, on the authority of Arthur Young, and the *Bath Memoirs*, [1783] states that

"in some parts of England, where husbandry is successfully practised, *any loose clay is called marl:* in others, *marl is called chalk*, and in others, *clay is called loam.*"—*Kirwan on Manures, p.* 4.

2. The learned and practical Miller thus defines and describes marl, in the abridgment of the *Gardener's Dictionary*, fifth London edition, at the article *marl.*

"Marl is a kind of clay which is become fatter and of a more enriching quality, by a better fermentation, and by its having lain so deep in the earth as not to have spent or weakened its fertilizing quality by any product. Marls are of different qualities in different counties of England.—"

He then names and describes ten varieties, most of them being very minutely and particularly characterized—and in only two of the ten, is there any allusion to a calcareous ingredient, and in these, it is evidently not deemed to constitute their value as manures. These are "the cowshut marl" of Cheshire, which—

"is of a brownish color, with blue veins in it, and little lumps of chalk or limestone"—and "clay-marl; this resembles clay, and is pretty near akin to it, but is fatter, and sometimes mixed with chalk stones.

"The properties of any sorts of marls, by which the goodness of them may be best known, are better judged of by their purity and uncompoundedness, than their color: as if it will break in pieces like dice, or into thin flakes, or is smooth like lead ore, and is without a mixture of gravel or sand; if it will shake like slatestones, and shatter after wet, or will tumble into dust, when it has been exposed to the sun; o will not hang and stick together when it is thoroughl dry, like tough clay; but is fat and tender, and wil open the land it is laid on, and not bind; it may b taken for granted that it will be beneficial to it."

3. *Johnson's Dictionary* (Octavo edition) defines marl in precisely the words of the first sentence of Miller, as quoted above.

4. *Walker's Dictionary* (Octavo edition) give only the following definition—"marl—a kind c clay much used for manure."

5. *A Practical Treatise on Husbandry*, (2n London edition 4to, 1762,) which professes to b principally compiled from the writings of Duhamel, Evelyn, Home, and Miller, supplies the following quotations.

"But of all the manures for sandy soils, none is s good as marl. There are many different kinds an colors of it, severally distinguished by many writer but their virtue is the same; they may be all use upon the same ground, without the smallest differenc in their effect. The color is either red, brown, yellow, grey, or mixed. It it to be known by its pur and uncompounded nature. There are many marks t distinguish it by; such as its breaking into little squa bits; its falling easily into pieces, by the force of blow, or upon being exposed to the sun and the fros its feeling fat and oily, and shining when 'tis dry. *Bu the most unerring way to judge of marl, and know from any other substance,* is to break a piece as big a nutmeg, and when it is quite dry, drop it into glass of clear water, where, if it be right, it will dissolve and crumble, as it were, to dust, in a little tim shooting up sparkles to the surface of the water."—p. 27.

—Not the slightest hint is here of any calcareou ingredient being necessary, or even serving i any manner to distinguish marl. But afterward in another part of this work, when *shell marl* slightly noticed, it is said,

"this effervesces strongly with all acids, which is pe haps chiefly owing to the shells. *There are very goo marls which show nothing of this effervescence:* an therefore the author of the *New System of Agricultu* judged right in making its solution in water the di tinguishing mark."—p. 29.

The last sentence declares, as clearly as an words could do, that, in the opinion of the auth no calcareous ingredient is necessary, either constitute the character, or the value of marl. An though it may be gathered from other parts this work, that what is called marl generally co tains calcareous earth, yet no importance seen attached to that quality, any more than to the pa ticular color of the earth, or any other accident or immaterial appearance of some of the varieti described.

The "shell marl" alluded to above, without e planation might be supposed to be similar to o beds of fossil shells, which are called marl. Th two manures are very different in form, appea ance, and value, though agreeing in both bei calcareous. The manure called shell marl by t work last quoted from, is described there wi sufficient precision, and more fully in several pa of the Edinburgh Farmer's Magazine,* and the Memoirs of the Philadelphia Agricultural S ciety.† It is still more unlike *marl* properly

* See Farmers' Register, Vol. I. p. 90.

† Vol. 3. p. 206.

alled, than any of the substances described under hat name, in the foregoing quotations. This nanure is almost a pure calcareous earth, being ormed of the remains of small fresh-water shells eposited on what were once the bottoms of lakes, ut which have since become covered with *bog* or *eat* soil. If I may judge from our beds of musle shells, (to which this manure seems to bear nost resemblance,) much putrescent animal mater is combined with, and serves to give additional alue to these bodies of shells. This kind of manure is sold in Scotland by the bushel, at such rices, as show that it is very highly prized. It eems to be found but in few situations, and hough called a kind of marl, is never meant vhen that term alone is used generally.

The opinions expressed in the foregoing exracts, prove sufficiently that it was not the ignoant cultivators only, who either did not know of, or attached no importance to the calcareous ingrelient in marl: and it was impossible, that from ny number of such authors, an American reader could learn that either the object, or the effect of *narling*, was to render a soil more calcareous—or hat our bodies of fossil shells resembled marl in character, or in operation, as a manure. Of this, the following quotation will furnish striking proof—and the more so, as the author refers frequently to the works of Anderson, and of Young, who treated of marl and calcareous manures, in a more scientific manner than had been usual. This author, Bordley, cannot be justly charged with inattention to the instruction to be gained from books: for his greatest fault, as an agriculturist, is his fondness for applying the practices of the most improved husbandry of England, to our lands and situations, however different and unsuitable—which he carries to an extent that is ridiculous as theory, and would be ruinous to the farmer who should so shape his general practice.

6. "I farmed in a country [the Eastern Shore of Maryland] where habits are against a due attention to manures: but having read of the application of marl as a manure, I inquired where there was any in the peninsula of the Chesapeake, *in vain*. My own farm had a grayish clay, which to the eye was marl: but because it did not effervesce with acids, it was given up, when it ought to have been tried on the land, especially as it rapidly crumbled and fell to mud, in water, with some appearance of effervescence."—*Bordley's Husbandry, 2nd ed. p.* 55.

That peninsula, through which Mr. Bordley in vain inquired for marl, has immense quantities of the fossil shells which we so improperly call by that name. But as his search was directed to *marl* as described by English authors—and not to calcareous earth simply—it is not to be wondered at that he should neither find the former substance, nor attach enough importance to the latter, to induce the slightest remark on its probable use as manure.

7. The *Practical Treatise on Husbandry*, among the directions for improving clay land, has what follows.

"Sea sand and sea shells are used to great advantage as a manure, chiefly for cold strong [i. e. clay] land, and loam inclining to clay. They separate the parts; and the *salts* which are contained in them are a very great improvement to the land. Coral, and such kind of stony plants which grow on the rocks, are filled with salts, which are very beneficial to land. But as these bodies are hard, the improvement is not the first or second year after they are laid on the ground, because they require time to pulverize them, before their salts can mix with the earth to impregnate it. The consequence of this is, that their manure is lasting. Sand, and the smaller kind of sea weeds, will enrich land for six or seven years: and shells, coral, and other hard bodies, will continue many years longer.

"In some countries *fossil shells* have been used with success as manure; but they are not near so full of salts, as those shells which are taken from the sea shore; and therefore the latter are always to be preferred. Sea sand is much used as manure in Cornwall. The best is that which is intimately mixed with coral."—p. 21.

After stating the manner in which this "excellent manure" is taken up from the bottom, in barges, its character is thus continued:

"it [i. e. the sea sand mixed with coral, as it may happen,] gives the heat of lime, and the fatness of oil, to the land it is laid upon. Being more solid than shells, it conveys a greater quantity of fermenting earth in equal space. Besides, it does not dissolve in the ground so soon as shells, but decaying more gradually, continues longer to impart its warmth to the juices of the earth."

Here are described manures which are known to be calcareous, which are strongly recommended—but solely for their supposed mechanical effect in separating the parts of close clays, and on account of the salts derived from sea water, which they contain. Indeed, no allusion is made to any supposed value, or even to the presence of calcareous earth, which forms so large a proportion of these manures: and the fossil shells, (in which that ingredient is more abundant, more finely reduced, and consequently more fit for both immediate and durable effects,) are considered as less efficacious than solid sea shells—and inferior to sea sand. All these substances, besides whatever service their salts may render, are precisely the same kind of calcareous manure, as our beds of fossil shells furnish in a different form. Yet neither here nor elsewhere, does the author intimate that these manures and marl have similar powers for improving soils.

The foregoing quotations show what opinions have been expressed by English writers of reputation—and what opinion would be formed by a general reader of these and other agricultural works, of the nature of what is called marl, in England, as well as what is so named in this part of our country. I do not mean that other authors have not thought more correctly, and sometimes expressed themselves with precision on this subject. Mineralogists define *marl*, to be a *calcareous clay**—and in this correct sense, the term is used by Davy, and other chemical agriculturists. Such authors as Young, and Sinclair, also could not have been ignorant of the true composition of marl—yet even they have used so little precision or clearness, when speaking of the effects of marling, that their statements, (however correct they may be in the sense they intended them,) convey no exact information, and have not served to remove the erroneous impressions made by the great body of their predecessors. Knowing as Young did [see first quotation] the confusion in

* Cleaveland's Mineralogy.

which this subject was involved, it was the more incumbent on him to be guarded in his use of terms so generally misapplied. Yet considering his practical and scientific knowledge as an agriculturist, his extensive personal observations, and the quantity of matter he has published on soils and calcareous manures, his omissions are more remarkable than those of any other writer. In such of his works as I have met with, though full of strong recommendations of marling, in no case does he state the composition of the soil, (as respects its calcareous ingredient,) or the proportion added by the operation—and generally notices neither, as if he viewed marling just as most others have done. These charges are supported by the following extracts and references.

8. Young's *Farmer's Calendar*, 10th London edition, page 40.—On marling. Through nearly four pages this practice is strongly recommended —but the manures spoken of, are regularly called "marl or clay," and their application, "marling or claying." Mr. Rodwell's account of his practice is inserted at length. On leased land he "clayed or marled" eight hundred and twenty acres with one hundred and forty thousand loads, and at a cost of four thousand nine hundred and fifty-eight pounds—and the business is stated to have been attended with great profit. At last, the author lets us know that it is not the same substance that he has been calling "marl or clay"—and that the marl effervesces strongly with acids, and the clay slightly. But we are told nothing more precise as to the amount of calcareous ingredients, either in the manures, or the soil—and even if we were informed on those heads, (without which we can know little or nothing of what the operation really is,) we are left ignorant of how much was clayed, and how much marled. It is to be inferred, however, that the clay was thought most serviceable, as Mr. Rodwell says—

"clay is much to be preferred to marl on those sandy soils, some of which are loose, poor, and even a black sand."

9. Young's *Survey of Norfolk*, (a large and closely printed octavo volume,) has fourteen pages filled with a minute description of the soils of that county—but without any indication whatever of the proportion, presence, or absence, of calcareous earth in that extensive district of sandy soils, so celebrated for their improvement by marling—nor in any other part of the county. The wastes are very extensive: one of them (page 385) eighteen miles across, quite a desert of sand, "yet highly improveable." Of this also, no information is given as to its calcareous constitution.

10. The section on marl (page 402, of the same work) gives concise statements of its application, with general notices of its effects, on near fifty different parishes, neighborhoods, or separate farms. Among all these, the only statements from which the calcareous nature of the manure may be gathered, are, (page 406) of a marl that "ferments strongly with acids"—another, (page 409,) that marling at a particular place destroys sorrel—and (page 410) that the marl is generally calcareous, and that *that containing the most clay, and the least calcareous earth*, is preferred by most persons, but not by all.

Young's *General View of the Agriculture of Suffolk*, (an octavo of 432 pages of close print,) in the description of soils, affords no information as to any of them being calcareous, or otherwise: yet the author mentions (page 3) having analyzed some of the soils, and reports their aluminous and silicious ingredients. Nor can more be learned, in this respect, in the long account afterwards given of the "marl" which has been very extensively applied also in the county of Suffolk. We may gather however from the following extracts, that the "marl or clay" of Suffolk, is generally calcareous, but that this quality is not considered the principal cause of its value—and further, that *crag*, a much richer calcareous manure, (which seems to be the same with our richest beds of fossil shells, or marl,) is held to be injurious to the sandy soils, which are so generally improved by what is *there* called marl.

11. "Claying—a term in Suffolk, which includes marling; and indeed the earth carried under this term is very generally a clay marl; though *a pure, or nearly a pure clay, is preferred for very loose sands.*"—*Young's Suffolk, p.* 186.

12. After speaking of the great value of this manure on light lands, he adds—

"but when the clay is not of a good sort, that is, when there is really none, or scarcely any clay in it, but is an imperfect and even a hard chalk, there are great doubts how far it answers, and in some cases has been spread to little profit."—p. 187.

13. "Part of the under stratum of the county is a singular body of cockle and other shells, found in great masses in various parts of the country, from Dunwich quite to the river Orwell, &c."—"I have seen pits of it to the depth of fifteen or twenty feet from which great quantities had been taken for the purpose of improving the heaths. It is both red and white, and the shells so broken as to resemble sand. On lands long in tillage, *the use is discontinued*, as it is found to make the sands blow more." [That is, to be moved by the winds.]—p. 5.

13. The *Essay on Manures* by Arthur Young, for which the author was honored with the Bedford medal, speaks distinctly enough of the value of marl being due to its calcareous ingredient, (as this author doubtless always knew, notwithstanding the looseness of most of his remarks on this head—) but at the same time he furnishes some of the strongest examples of absurd inferences, or of gross ignorance of the mode in which calcareous earth acts as an ingredient of soil, and the proportion which soils ought to contain. These are his statements, and his reasoning thereon:

"It is extremely difficult to discover, from the knowledge at present possessed by the public, what ought to be the quantity of calcareous earth in a soil. The best specimen analyzed by Giobert, had 6 per cent. by Bergman, 30 per cent.; by Dr. Fordyce, 2 per cent. a rich soil, quoted by Mr. Davy, in his lecture at the Royal Institution, 11 per cent. This is an inquiry concerning which I have made many experiments and on soils of the most extraordinary fertility. In one, the proportion was equal to 9 per cent.; in another, 20 per cent.; another, 3 per cent.; and in a specimen of famous land, which I procured from Flanders 17 per cent. But the circumstance which much perplexes the inquiry is, that many poor soils possess the same or nearly the same proportions, as these most fertile ones. To attain the truth in so important a point induced me to repeat many trials, and to compare every circumstance; and I am disposed to conclude, *that the necessity of there being a large proportion of calcareous earth in a soil, depends on the deficiency of organi-*

i. vegetable or animal] *matter;* of that organic mat- which is [partly] convertible into hydrogen gas. If farmer finds, by experiment, that his soil has but a ll quantity of organic matter, or knows by his prac- that it is poor, and not worth more than 10s., 15s. or an acre, *he may then conclude that there ought to be ver cent. of calcareous earth in it;* but if, on the con- y, it abound with organic matter, and be worth in ctice a much larger rent, in that case his marl cart not be called for, though there be but five per cent. ven less, of calcareous matter."—*Young's Essay on nures*—Sect. 2.

t is scarcely necessary to show, that the opin- of calcareous matter, being needed in larger ntities in proportion to the deficiency of pu- scent matter, is directly opposed to the reasoning this essay. If a poor soil were made to contain nty per cent. of calcareous matter, by applying e, chalk, or marl, the quantity and the expense uld be so enormous as not to be justified by any sible return—and in truth, would lessen, rather n increase, the product of a poor soil. The fact ned as strange, by Young, that some rich soils tain very small, and others very large propor- ns of calcareous earth, is easily explained. If a ural soil contains any excess of calcareous earth, n though but one per cent., it shows that there hat much to spare after serving every purpose neutralizing acids and combining with putres- t matter. If there were twenty per cent. more alcareous matter, it would be useless, until met an additional supply of putrescent matter. ung's statement that some poor soils agree pre- ely with other rich soils, in their contents of cal- eous earth, does not necessarily contradict my trine that a proper proportion of calcareous th will enable any soil to become rich, either in state of nature, or under mild cultivation— d for the following reasons:

4. 1st. The correctness of Young's analyses may well doubted—and if he used the then usual cess for separating calcareous earth, he was iged to be incorrect, on account of its unavoida- imperfection, as has been already explained at ge 18. 2d. It cannot be known positively at was the original, state of fertility of most tivated soils in England, nor whether they were jected to exhausting or improving cultivation, centuries before our information from history gins. 3d. Lime has been there used for a long e, and to great extent; and chalk and marl re applied as manures during the time of the man conquest, as stated by Pliny, (say 1700 ars ago)—so that it cannot be always known nether a soil has received its calcareous ingredient m nature, or the industry of man. 4th. It is own that severe cropping after liming, and also cessive doses of calcareous earth, have render- land almost barren: of which the following ex- cts offer sufficient proof:—

Before 1778, [in East Lothian] the *outfield* did not eive any dung except what was left by the animals zed upon it. In many cases, outfield land was ed; and often with singular advantage. The after nagement was uniformly bad; it being customary to p the limed outfield with barley and oats successive- so long as the crop was worth cutting. In this way merous fields suffered so severely as to be rendered most steril for half a century afterwards." *Farmer's agazine, p.* 53, *Vol.* 12.

" An overdose of shell marl, laid perhaps an inch ick, produces for a time large crops. But at last it renders the soil a *caput mortuum*, capable of neither corn nor grass; of which, there are too many examples in Scotland, &c. *Gentleman Farmer, p.* 378.

15. Yet the last writer (Lord Kames) elsewhere states, (at page 379) that as much clay marl as contains 1500 bolls, (on 9000 bushels) of pure calcareous earth to the acre, is not an overdose in Scotland.

16. "*Marl.* Of this substance, there are four sorts, rock—slate—clay—and shell marl. The three former are of so heavy a nature that they are seldom conveyed to any distance; though useful when found below a *lighter* soil. But shell marl is specifically lighter, and consists entirely of calcareous matter, (the broken and partially decayed shells of fish,) which may be applied as a top dressing to wheat and grass, when it would be less advantageous to use quicklime." [This is the kind of manure referred to in extract 5, and there more particularly described.] "In Lancashire and Cheshire, clay, or red marl, is the great source of fertilization, &c."—"The quantity used is enormous; in many cases about three hundred middling cart loads per acre, and the fields are sometimes so thickly covered as to have the appearance of a red soiled fallow, fresh ploughed."—*Sinclair's Code of Agriculture, American Ed. (Hartford) p.* 138.

This account of the Lancashire improvements made by red clay marl, closes with the statement that "the effects are represented to be beneficial in the highest degree"—which is fully as exact an account of profit, or increased production, as we can obtain of any other marling. Throughout, there is no hint as to the calcareous constituents of the soil, or the manure, or whether either rock, clay or slate marls generally, are valuable for that, or for other reasons; nor indeed could we guess that they contained any calcareous earth, but for their being classed, with many other substances, under the general head of calcareous manures.

17. "The means of ameliorating the texture of *chalky* soils, are either by the application of clayey and sandy loams, pure clay, or *marl.*"—"The chalk stratum sometimes lies upon a thick vein of black tenacious marl, of a rich quality, which ought to be dug up and mixed with the chalk."—*Code of Agriculture, p.* 19.

18. Dickson's *Farmer's Companion.*—The author recommends "argillaceous marl" for the improvement of *chalky soils:* and for sandy soils, "where the calcareous principle is in sufficient abundance, *argillaceous marl*, and clayey loams," are recommended as manures.

19. "Chalky loam. The best manure for this soil is clay, or *argillaceous marl,* if clay cannot be had; because this soil is defective principally in the argillaceous ingredient."—*Kirwan on Manures, p.* 80.

The evident intention and effect of the marling recommended in all the three last extracts, is to *diminish* the proportion of calcareous earth in the soil.

20. In a *Traveller's Notes* of an agricultural tour in England, in 1811, which is published in the third volume of the *Edinburgh Farmer's Magazine*, the following passages relate to Mr. Coke's estate, Holkham, and to Norfolk generally.

"Holkham.—The soil here is naturally very poor, being a mixture of sand, *chalk*, and flint stones, with apparently little mixture of argillaceous earth—*the subsoil, chalk or limestone every where.*" Page 486.

"As the soil of the territory [of Norfolk generally] through which I passed, seems to have *a sufficient mixture of calcareous earth naturally*, I learn they do not often lime their lands; but *clay marl* has been found to have the most beneficial consequences on most of the Norfolk soils."—*p.* 487.

21. "In Norfolk, they seem to *value clay more than marl*, probably because their sandy soils already contain *calcareous parts*."—*Kirwan on Manures, p.* 87.

From this and the preceding quotation it would follow, that the great and celebrated improvements in Norfolk, made by marling, had actually operated to *lessen the calcareous proportion of the soil*, instead of increasing it. Or, (as may be deduced from what will follow,) if so scientific and diligent an inquirer as Kirwan, was deceived on this very important point, it furnishes additional proof of the impossibility of drawing correct conclusions on this subject from European books—when it is left doubtful, whether the most extensive, the most profitable, and the most celebrated improvements by "marling," in Europe, have in fact served to make the soil *more* or *less* calcareous.

Most of the extracts which I have presented, are from British agriculturists of high character and authority. If such writers as these, while giving long and (in some respects) minute statements of marl, and marling, omit to tell, or leave their readers to doubt, whether the manure or the soil is the most calcareous—or what proportions of calcareous earth, or whether any, is present in either—then have I fully established that the American reader who may attempt to draw instruction from such sources, as to the operation, effects and profits of either marl or calcareous manures, in general will be more apt to be deceived and misled, than enlightened.

I have now to refer to an author, whose works, well known as they may be to others, had not come under my view until after the publication of most of the foregoing extracts. Otherwise, Marshall would have been stated as an exception to the general silence of British authors as to the true and precise nature of what they treated of as *marl*. But though he has not been, like others, so faulty as to leave in doubt what was the character and value of the marls, of which he spoke, and the nature of their operation on the soils to which they were applied—still no other writer furnishes stronger proof of the general ignorance and disregard of the nature of marls and calcareous manures, and of their mode of operation; and even the author himself is not free from the same charge, as will be shown. I shall quote more at length from Marshall, because he presents the strongest opposition to what I have stated as to the general purport of publications on marling: and also, because, whatever may be their character, there is much to interest the reader in his accounts of the opinions and practices of those who have used calcareous manures longest, and most extensively, although without knowing what they were doing.

In his *Rural Economy of Norfolk*, the "marls" and "clays" most used in the celebrated improvements of that county are minutely described, and the chemical composition stated—showing that both are highly calcareous. Of the "marls," or chalks, most used for manure in Norfolk, he analyzed three specimens, and one of clay, and found the proportions of pure calcareous matter as follows:

| | |
|---|---|
| Chalk marl of Thorp-market, contained, | $\frac{35}{100}$ |
| Soft chalk of Thorp-next-Norwich, | $\frac{98}{100}$ |
| Hard chalk of Swaffham, almost pure— | |
| Clay marl of Hemsby, | $\frac{43}{100}$ |

22. Of these he spoke previously and in gene[ral] terms, thus:

"The central and northern parts of the distr[ict] abound, universally, with a whitish-colored chalk ma[rl]; while the Fleg Hundreds, and the eastern coast, [are] equally fortunate in a gray-colored clay marl.

"The first has, in all probability, been in use as [a] manure many centuries: there are oaks of considera[ble] size now going to decay in pits which have obviou[sly] been heretofore in use, and which, perhaps, still rem[ain] in use, as marlpits.

"The use of clay marl, as a manure, seems to b[e a] much later discovery; even yet, there are farmers w[ho] are blind to its good effect; because it is not *marl*, [but] "clay;" by which name it is universally known.

"The name, however, would be a thing of no impo[rtance] were it not indiscriminately applied to unctuous earth[s in] general whether they contain, or not, any portion of c[al]careous matter. Nothing is "marl" which is not wh[ite]; for, notwithstanding the county has been so long and largely indebted to its fertilizing quality, her husba[nd]men, even in this enlightened age, remain totally [ig]norant of its distinguishing properties: through wh[ich] want of information much labor and expense is [fre]quently thrown away.

"One man seeing the good effect of the Fleg cl[ay], for instance, concludes that all clays are fertile, [and] finding a bed of strong brick earth upon his farm, f[alls] to work, at a great expense, to "claying:"—while [an]other observing this man's miscarriage, concludes t[hat] all clays are unprofitable; and, in consequence, is at [an] expense, equally ill applied, of fetching "marl" fro[m a] great distance; while he has, perhaps, in his own fa[rm], if judiciously sought after, an earth of a quality equ[ally] fertilizing with that he is throwing away his time [and] his money in fetching. *Marshall's Norfolk Vol.* [...] *p.* 16.

Yet it is remarkable, that Marshall should [not] have intimated whether the Norfolk soils w[ere] naturally calcareous, (as the two writers just [be]fore quoted declare,) or not—and therefore we [are] still left to guess whether these manures serve[d to] increase the calcareous quality of soils alre[ady] possessing that quality in a high degree—or [to] give it to soils devoid of it before.

Other passages will now be quoted from [the] same, and from other similar works of Marsha[ll], to show the prevailing ignorance of the ingredie[nts] and operation of the marls sometimes priz[ed], and sometimes contemned, with as little reaso[n in] the one case as the other, by farmers in vari[ous] parts of England.

23. "The principal part of his estate, however, [is] a much shallower soil, not deeper than the plough g[oes]; and its present very amazing fertility he ascribes [in a] great measure, to his having clayed it. Indeed to [this] species of improvement the fertility of the Fleg H[un]dred is allowed to be principally owing.

"Mr. F. gave me an opportunity of examining [his] clay pit, which is very commodious; the uncallo[w is] trifling, and the depth of the bed or jam he has not [been] able to ascertain. It is worked, at present, about [ten] or twelve feet deep.

"The color of the fossil, when moist, is dark bro[wn], interspersed with specks of white; and dries [a] color lighter than that of fuller's earth; on being [ex]posed to the air, it breaks into small die-like pieces.

"From Mr. F's. account of the manner of its ac[tin]g, and more particularly from its appearance, I judg[e]

be a brown marl, rather than a clay; and, on trying it in acid, it proves to be strongly calcareous; effervescing, and hissing, more violently than most of the white marls of this neighborhood: and what is still more interesting, the Hemsby clay is equally turbulent in acid as the Norwich marl, which is brought by water forty miles into this country, at the excessive expense of four shillings a load upon the staith; besides the land carriage. [The strength of this Hemsby clay is stated above.]

'It is somewhat extraordinary that Mr. F., sensible and intelligent as he is, should be entirely unacquainted with this quality of his clay; a circumstance, however, the less to be wondered at, as the Norfolk farmers, in general, are equally uninformed of the nature and properties of marl." *Marshall's Norfolk, Vol. II, page* 32.

The following is a remarkable instance, in a particular district, of a clay, very poor in calcareous matter, being considered and used as valuable manure, and a very rich marl equally accessible, being deemed inferior.

24. "The marl is either an adulterate chalk, found near the foot of the chalky steeps of the West Downs, lying between the chalk rock and the Maam soil, partaking of them both—in truth, a marl of the first quality; or a sort of blue mud, or clay, dug out of the area of this district, particularly, I believe, on the south side of the river. This is said to have been set on, with good effect; while the former is spoken of, as of less value; whereas, the white is more than three-fourths of it calcareous; while the blue does not contain ten grains, per cent., of calcareous matter." *Marshall's Southern Counties, Vol. p.* 175.

The greater part of what are called marls in the following extract, and used as manure, contain so little calcareous earth, that whatever power they may exert, must be owing to some other ingredient. Yet without Marshall's analysis, they would be considered to deserve the character of calcareous manures, as much as any others before named.

25. "The red earth which has been set upon the lands of this district, in great abundance, as "marl,"—is much of it in a manner destitute of calcareous matter; and, of course, cannot, with propriety, be classed among marls.

"Neverthless, a red fossil is found, in some parts of the district, which contains a proportion of calcareous matter.

"The marl of Croxall (in part, of a stonelike, or slaty contexture, and of a light red color) is the richest in calcareosity: one hundred grains of it afford *thirty grains* of calcareous matter; and seventy grains of fine, impalpable, red-bark-like powder.*

"And a marl of Elford (in color and contexture various, but resembling those of the Croxall marl) affords near *twenty grains*:

"Yet the marl of Barton, on the opposite side of the Trent—though somewhat of a similar contexture, but of a darker more dusky color—is in a manner destitute of calcareosity! one hundred grains of it yielding little more than one grain—*not two grains* of calcareous matter. Nevertheless, the pit, from which I took the specimens analyzed, is an inmense excavation, out of which many thousand loads have been taken.

"And the marls of this neighborhood (which mostly differ in appearance from those described, having generally that of a blood-red clay, interlayered, and sometimes intermingled, with a white gritty substance) are equally poor in calcareosity.

One hundred grains of the marl of Statfold (which I believe may be taken as a fair specimen of the red clays of this quarter of the district) afford little more than *two grains* of calcareous matter.* Yet this is said to be "famous marl;" and, from the pits which now appear, has been laid on in great abundance.

"I do not mean to intimate, that these clays are altogether destitute of fertilizing properties, on their first application. It is not likely that the large pits which abound, in almost every part of the district, and which must havebeen form ed at a very great expense, should have been dug, without their contents being productive of some evidently, or at least apparently, good effect, on the lands, on which they have been spread.

I confess, however, that this is but conjecture; and it may be, that the good effect of the marls, first described being experienced, the *fashion* was set; and, the distinguishing quality being unknown, or not attended to, marls and clays were indiscriminately used." *Marshall's Midland Counties, Vol. I. p.* 152.

26. "On the southern banks of the Anker, is found a grey marl; resembling, in general appearance, the marl of Norfolk, or rather the fuller's earth of Surray. In contexture, it is loose and friable.

"This earth is singularly prodigal of its calcareosity. The acid being dropped on its surface, it flies into bubbles as the Norfolk marl. This circumstance, added to that of a striking improvement, which I was shown as being effected by this earth, led me to imagine, that it was of a quality similar to the marls of Norfolk.

"But, from the results of two experiments—one of them made with granules formed by the weather, and collected on the site of improvement, the other with a specimen taken from the pit it appears that one hundred grains of this earth contain no more than *six grains* of calcareous matter! the residuum a cream colored saponaceous clay, with a small proportion of coarse sand." *Marshall's Midland Counties, Vol. I. p.* 155.

The last extracts suggest a remark which ought to have been made earlier. When there is so much general ignorance prevailing among practical farmers as to what they call marl, it cannot be expected that the most intelligent writers can be correct, when attempting to record their practices. When Arthur Young, for example, reports the effects of marl in fifty different localities, as known from the practice of perhaps more than several hundred individuals, it must be inferred that he uses the term generally, as they did from whom his information was gathered—and in very few cases, if at all, as learned by his own analyses. Therefore, it may well be doubted whether the uncertainty as to the character of marl does not extend very generally to even the most scientific writers on agriculture.

As the foregoing exhibits the use of "marls" destitute of calcareous earth, so the following shows under the name of *sea sand*, a manure which is in its chemical qualities a rich *marl* (in our sense) or calcareous manure.

27. "*Sea-sand.* This has been a manure of the district, beyond memory, or tradition.

"There are two species still in use: the one bearing the ordinary appearances of sea sand, as found at the

* This marl is singularly tenacious of its calcareous matter; dissolving remarkably slowly. One hundred grains, roughly pounded, was twenty-four hours in dissolving; and another hundred, though pulverized to mere dust, continued to effervesce twelve hours; notwithstanding it was first saturated with water, and afterward shook repeatedly. The Breedon stone, roughly pounded, dissolved in half the time; notwithstanding its extreme hardness.

* Lodged not in the substance of the clay; but in its natural cracks or fissures.

mouths of rivers; namely a compound of the common sand and mud: the other appears, to the eye, clean fragments of broken shells, without mixture; resembling, in color and particles, clean-dressed bran of wheat.

"By analysis, one hundred grains of the former contain about thirty grains of common silicious sea sand, with a few grains of fine silt or mud; the rest is calcareous earth, mixed with the animal matter of marine shells.

"One hundred grains of the latter contain eighty-five grains of the matter of shells, and fifteen grains of an earthy substance, which resembles, in color and particles, minute fragments of burnt clay, or common red brick.

"These sands are raised in different parts of Plymouth Sound, or in the harbor; and are carried up the estuaries, in barges; and from these, on horseback, perhaps five or six miles, into the country; of course at a very great expense: yet without discrimination, by men in general, as to their specific qualities. The shelly kind, no doubt, brought them into repute, and induced landlords to bind their tenants to the use of them; but without specifying the sort—and the bargemen, of course, bring such as they can raise, and convey, at the least labor and expense. It is probable that the specimen first mentioned, is above par, as to quality: I have seen sand of a much cleaner appearance, travelling towards the fields of this quarter of the country: and, near Beddiford; in North Devonshire, I collected a specimen, under the operation of "melling" with mould, which contains eighty grains per cent. of clean silicious sand!" —*Marshall's West of England, Vol. I. page* 154.

It might be inferred from all these proofs of Marshall's knowledge of calcareous earth constituting the real value of marls, that he could scarcely miss the evident corollary to that proposition, that the valuable operation of calcareous manures is to render soils more calcareous—and that the knowledge of the nature of the manure and the soil, would sufficiently indicate when the application of the one to the other was judicious or not. But the following expression of opinion (*Marshall's Yorkshire, Vol. I. p.* 377) is not only strongly opposed to those deductions, but to the general purport of all his truths which I have before quoted.

28. "Nothing at present but comparative experiments can determine the value of a given lime, to a given soil; and no man can, with common prudence, lime any land, upon a large scale, until a moral certainty of improvement has been established by experience."

If this be true, then indeed is there no true or known theory, or established precepts, for applying either lime, or any calcareous manure. It amounts to saying, that every new application is a mere experiment, the result of which cannot even be conjectured from any facts previously known of other soils and other manures.

29. The next quotation, which is from an editorial article in the *Farmer's Journal* of July 28, 1823, shows that the old opinion still prevails, that marl is profitable only on sandy lands; which opinion carries with it the inference that it is the argillaceous quality, rather than the calcareous, that operates. The editor is remarking on a new agricultural compilation by a Mr. Elkinson, and ridiculing the author for his solemn annunciation of the truism (in the editor's opinion,) that, "marling on sand is more useful than on clay land." The reputation of Mr. Elkinson, says the editors,

"may remain undisturbed among the farmers of Lincolnshire for a long time, who may never have chanced to meet with the old proverb, or have taken a journ into the sandy district of Norfolk. We really do n know whether it be as old Jervais Markham, or n but we have seen the following lines in black letter:

He that marls sand, may buy land;
He that marls moss, shall have loss;
He that marls clay, throws all away!"

The editor then passes to a subject on whi his admitted ignorance serves to prove that t improvement gained by marling could not be si ply the making a soil calcareous—for upon th ground, when marl has once been plentifully give and the land afterwards worked poor, there can neither reason nor profit, in a second marling. Y as if the mode of operation was altogether u known, this passage follows.

"It was once asked of the editor by a very good pra tical Norfolk farmer, 'whether land which had been or marled and worn out, would receive the same bene from a second marling?' It was answered, that an e periment made on one field, or on one acre, wo decide the point, but *conjecture led to nothing conc sive*. It has often been observed that loose land, af having been marled and out cropped, deposited its m in the subsoil, which therefore became more retent [of water;] and it has been suggested, that de ploughing ought to be tried, to bring this marl ag to the top. We hope that the point here in questi has before now been settled by practice in both wa though at the above period, (about 1806) such fa had not reached the gentleman alluded to, althoug very intelligent man."

The singular fact stated above, of marl, and a of lime, sinking and forming a layer below t soil, is stated by other British writers. No su result has been found in this country, so far as am informed. Nor do I believe that it can occ except when the calcareous matter is too abu dant to form a chemical combination with the s or with the matters in the soil. According to n views of the manner in which calcareous ea acts, it must form such combinations in the s to be useful—and if so combined, it cannot be parated, and sink through the soil by the force gravity, or any other cause.

30. The next article is probably one of the lat publications on marl, yet contains as little truth, and for its length, as much that is false a absurd, as if it had been written a century ago. appears in the last number of the *Quarterly Jo nal of Agriculture*, (for Dec. 1834) and is th quoted from the *Magazine of Gardening and B tany*, and as written by Count Gyllenborg. no contradictory remarks are appended by eit of the editors of these highly respectable journa it may be considered as in some measure givi countenance to the opinions here presented.

Though the writer speaks of "acid in the lan yet the succeeding part of the sentence wh speaks of "imbibing it from stagnating wat shows that no correct or definite idea was attacl to the term "acid." The entire piece is copi

"*How far marl contributes to the fertility of so* 1st, Not materially, for it is devoid of every unctu and saline matter. 2d, But instrumentally, it prom vegetation, by attracting the moisture, acids or oil the atmosphere, which enrich the land. As this qu ty becomes stronger by burning, how wisely would farmers act in using it after being calcined. It p motes vegetation, by destroying the acid actually in land, or removing that which it might be in dange

bibing from stagnating water, and hence, also, it may rhaps help to prevent a too acid disposition in the seeds. dissolving every unctuous substance in the land, nence arises a saponaceous mixture soluble in water, d fitted to enter into the pores of vegetables. By de-royinig the toughness of strong soils, for, by its quick-crumbling in the air, the cohesion of a clayey soil is minished, it is rendered easier to cultivate, and more to carry on growth of plants. It gives greater solid-y and firmness to loose or sandy soils; and, as before bserved, it contributes to their fertility, by attracting to this dry soil the nutritive contents of the air. There e some who think that marl should not be laid on ndy soils; but experience has taught us to conclude herwise, having observed that the most beneficial ef-cts are produced from it on very light and sandy soils. [arl may hurt land by too long and a too plentiful use ' it; for, from its calcareous quality, it much resem-es lime. It soon dissolves and consumes the fat of e land—and it loosens a clayey soil, so that it becomes ss retentive of moisture. Marl is, however, very fferent, according to its being more or less calcareous clayey; and therefore, judgement is more or less ecessary to adapt it to the nature of the soil. Some ave recommended it chiefly for wet and cold soils, and iany farmers have observed that it is most useful when iixed with rich manures. Neither of these observa-ons, however, seems to be correct; but a due care should e taken that this manure be adapted to the soil on hich it is laid."

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## [NOTE G 2. Page 36.]

### HE EARLIEST KNOWN SUCCESSFUL APPLI-CATIONS OF FOSSIL SHELLS AS MANURE.

The two old experiments described at page 36, hough the only applications of fossil shells known o me, previous to the commencement of my use f this manure, were not all which had been nade, and which being deemed failures, had been bandoned and forgotten. Another, within a few niles of my residence, was brought to light and notice afterwards, by an old negro, who was per-iaps the only person then living, who had any nowledge of the facts. After I had found enough uccess in using this manure to attract to it some ttention, Mr. Thomas Cocke of Aberdeen was ne of those who began, but still with doubt and esitation, to use marl to some considerable ex-ent. One of his early applications was to the arden. The old gardener opposed this, and told is master that he knew "the stuff was good for othing, because when he was a boy, his old aster (Mr. Cocke's father) had used some at Bonaccord, and it had never done the least good." Being asked whether he could show the spot where this trial had been made, he answered that he could easily, as he drove the cart which carried out the marl. The place was immediately sought. It was on the most elevated part of a very poor field, which had been cleared and exhausted fully a century before. The marled space (a square of about half an acre) though still poor, was at least wice as productive as the surrounding land, hough a slight manuring from the farm-yard had been applied a few years before to the surround-ng land, and omitted on this spot, which was sup-posed to have been, from its appearance, the site of some former dwelling house, of which every evidence had disappeared except the permanent mprovement of the soil usual from that course. A close examination showed some fragments of the hardest shells, so as to prove that the old man had not mistaken the spot. This, like other early applications, had been made on a spot too poor for marl to show but very small early effects—and as only one kind of operation of any manure was then thought of, (that which dung produces,) it is not strange that both the master and servant should have agreed in the opinion that the appli-cation was useless, and have remained under that opinion until almost all remembrance of the expe-riment had been lost.

There were also successful and continued uses of this manure in James City County, in Virginia, made earlier than mine; and still earlier by the Rev. John Singleton, in Talbot County, Mary-land. It appears that the early (though chance directed) combination of putrescent manures with marl in both these places, served to prove the va-lue of the latter, and perhaps to prevent it being there also abandoned as worthless, as in other cases. But though the application was continued, and with great success and profit, the knowledge of these facts, and the example, extended very slowly: and the then want of communication among farmers, for years kept all ignorant of these practices, except in the immediate vicinity of the commencement of each. I have since en-deavored to ascertain the time of the first applica-tions in James City, and have been informed that it was in 1816. Mr. Singleton's, in Maryland, were begun as early as 1805. His own account of his practice (which will be annexed entire, as an interesting statement of the earliest profitable use of this manure,) was first published in 1818, in the 4th volume of the Memoirs of the Phila-delphia Agricultural Society, (page 238.) The date of his letter is Dec. 31, 1817. My first ex-periment was made the following month (Jan. 1818,) but more than a year before I met with Mr. Singleton's publication, or had heard of any application of fossil shells, except the two failures mentioned in page 36. But however beneficial may have been found the operation of marl in Talbot and in James City, it is evident, from Mr. Singleton's letter, and from all other sources of in-formation, that the mode of operation remained altogether unsuspected by those who used it: and this was perhaps the principal cause why the practice was so slow in spreading. It is now thir-ty years since the first proofs were exhibited on the land of Mr. Singleton: yet, according to the report of the geological survey of the lower part of Maryland, (submitted to the legislature of Mary-land at its recent session of 1834–5,) it appears, that though the value of marl is well understood, and much use of it made in Talbot county, and part of Queen Anne's, it also appears that almost no use has been made of it on the other and much more extensive parts of the Eastern Shore of Ma-ryland—and none whatever west of the Chesa-peake in that state, where it is found in abun-dance. Such at least are the inferences from Mr. Ducatel's report, though in part drawn from indi-rect testimony, more than direct and particular as-sertions.

The slight, and almost contemptuous manner, in which marl is mentioned by so well informed an agriculturist as Taylor, as late as 1814, when his *Arator* was published, (and which remains un-altered in his 3d edition of 1817,) proves that al-

most nothing was then known of the value of this manure. All that seems to relate to our fossil shells is contained in the two following passages:

"Without new accessions of vegetable matter, successive heavy dressings with lime, gypsum, and even marl, have been frequently found to terminate in impoverishment. Hence it is inferred, that minerals operate as an excitement only to the manure furnished by the atmosphere. From this fact results the impossibility of renovating an exhausted soil, by resorting to fossils, which will expel the poor remnant of life; and indeed *it is hardly probable that divine wisdom has lodged in the bowels of the earth, the manure necessary for its surface.*"—*Arator p. 52, 2nd Ed. Baltimore.*

"Of lime and marl we have an abundance, but experience does not entitle me to say any thing of either."—p. 80.

*From the Rev. John Singleton, to the Hon. Wm. Tilghman.*

* * * * * * *

"Your first question is, 'whether what I use be marl, or soil mixed with shells?'

"Whether it be marl or not, I will not pretend to determine, as I have seen no description of marl that answers exactly to it; but Mr. Tench Tilghman informed me, he had seen a description of marl used in Scotland, exactly similar to what I use on the farm on which I reside, and which is the improved land you mention. I have not seen the account myself. However, this, and all mixtures of broken marine shells, of which there is a great variety, are now denominated marl, here. What I consider the best, and which I most use, is composed of small parts of marine shells, chiefly scallop shell, about one-eighth of an inch square, or somewhat longer or smaller, with scarce any sand or soil with it: some of it seems to be petrified, and is dug up in lumps, like stone, from four or five, to forty or fifty pounds in weight, hard to break even with the edge of an axe, and will remain for years, tumbled about with the plough, before it is entirely broken to pieces, and mixed with the soil; indeed you may observe it in some parts of the bank, where the soil has been washed from it, appearing like rock stone; but if broken and pulverized a little, it effervesces very much with acids. It lies from three to five and six feet deep, from the surface of a light or sandy soil, on the banks of the cove; but how deep the marl, or bed of shells goes, we cannot ascertain, having never dug through it. When we get from two to four feet deep into it, the water springs, so that we have never gone deeper, but fill up the hole with the surface soil, and open another. It does not lie level, but waving, sometimes dipping so deep that we lose it; nor is it of one color, but some white, like dry mortar, some the color of yellow ochre, some red, like red ochre, and some blueish: but I do not know any difference in the quality, from the color. In digging, it is generally loose and crumbly, but mixed with hard lumps as above described: we find sometimes whole shells of scallop, oyster, and barnacles. The kind I estimate most, is of the foregoing description, and I am of opinion it lies at different depths, under the whole of this peninsula, which has been gained from the water, and that the shells are of the different kinds of fish which inhabited the waters while they covered the land. In some places, at heads of coves, I have traced the shells by cutting a ditch from three to five feet deep, down the valley, and even through the marsh, till I came to tide water; but in this kind of low ground there were more whole, and large shells, and none of the large stone-like lumps above mentioned. It appears as if it had been the bottom of the creek, and as if covered by the water more lately than the first described. All these are on this farm. At my other farm, where my uncle formerly lived, and which is at the head of this creek, I find it by digging deep into the ditches, in the meadow ground, which empty into the head of the creek: but that kind differs from what I have here; as, besides the scallop shells, which ar not so much reduced as here, there is, for perche together, the clam shell, perfectly whole, but so sof that when thrown out of the ditch and exposed to th air, they soon fall away to powder: but the scallo shell seems most abundant; and of this kind of shel fish we have no knowledge. The beds of shell are t be discovered in many places, on the edges of th creek, and even out into the water; and are foun throughout the county, in most places where carefull sought for, but generally, I believe, a good deal mixe with sand. However, I have no doubt they may a be usefully applied as improvers of the soil: they ar now coming into the use of many persons in th county, who have discovered them on their land, an have adopted a regular system of manuring.

"Your next question is, 'to what kind of soils, an how it is applied; as a top dressing or ploughed in

"I have applied it to all the soils on my farm, som of which is a cold white clay, and wet; others a ligl loam, and sandy, I find it useful to each kind, an manure my land all over with it, without distinctio and to advantage; putting a smaller quantity upon th looser soils. I have applied it as a top dressing on cl ver, and also where clover has not been sown, with view to improving the grass, and also to be satisfie whether it would not be best for the ground, to let it li spread on the surface, for a year before the ground wa put into cultivation. But it has not answered my expe tation. I could not perceive any advantage from th mode of application. I now constantly apply it t the ground cultivated in corn; carting it out in the win ter and spring, and putting on from twenty to fort cart loads per acre, according to the ground, and th previous quantity that had been put on, in former cu tivations, dividing each load into from four to eigl small heaps, for the greater ease in spreading, accor ing to the size of the load. Some is put on before, ar some after the ground is broken up, but it is all worke into the soil by the cultivation of the corn, and it nev fails of considerably improving the crop of corn, a also the ground wherever the marl is, especially i largest quantity. There is a small green moss, ar black moist appearance, on the surface of the groun when not cultivated; as you perceive about old wall and in strong ground. Though the preceding is th common mode in which I use the marl, I do not thin it the best; I mix some in my farm yard, with the far yard and stable manure; and would prefer mixing ar applying all that I use thus mixed, but for the lab of double cartage, which I cannot as yet accomplis manuring so largely as I do. I cultivate one hundre acres yearly, and constantly manure the whole of wh I cultivate; employing only four carts, and four han with the carts, which do all the manuring and cartin on the farm.

"Your next question is, 'what has been my rotation o crops, and mode of cultivating, since I have used th manure?'

"Since I began to use the marl, and bend my atte tion to improvement by manure, I have cultivated onl corn and wheat, sowing my ground in clover, ar using the plaster. Instead of cultivating all my grour in corn, and sowing wheat on it as heretofore, I divide my cultivation into two parts, of fifty acres each, pu ting one part into corn, which I was able to accomplis manuring time enough for the corn, and making a fa low of the other part, manuring as much of it as could accomplish before the time for sowing whea and disregarding, in a degree, all smaller crops, whic I could not attend to, as an object, without increasi my number of hands, and interfering with the ma business. I went on in this manner, till I found I cou easily accomplish manuring one hundred acres and u wards, per annum. Having got my ground to that sta that I can risk making a crop without manure, I a now about discarding fallow, being able to manure m whole hundred acres time enough for cropping in th

ring, by beginning to manure for the next year as on as the spring manuring is finished. I shall in fure have no wheat in fallow, but sow it after corn and ner crops, from which I am satisfied I can make more om my ground than by naked fallow, which I always nsidered unprofitable, though you made more wheat, cept for the advantage of having more time to maure. The standing annual force on my farm is eight nds, (men,) with one hired by the month. Of these nds four are employed with the carts; two in ploughg, harrowing, &c. for the cultivation of the crop; d the other two or three, as may be, do the blacknith's and carpenter's work, as also the fencing and her work necessary on a farm: the six hands employ- with the carts and ploughs, are not taken off for her business, except in the time of harvest, and sowg wheat, when they are probably stopped. I do not ork so much with the plough as formerly, but more ith the harrow, which lessens and quickens the labor cultivation, keeps the ground cleaner, and, I think, better tilth. Occasionally I hire or employ some omen, for hoeing work and spreading manure. I ush my ground in large lands, and harrow and roll as may require; then, instead of listing, as common, ark it out each way with a plough, very shoal, so as ot to disturb the grass ploughed down, and after dropng the corn, cover it with the plough or harrow, and nmediately put in the harrow, keeping it going, as e weather will permit, till just before harvest, hen we plough the ground, and finish the cultiation with the harrow, except something should ccur, making it necessary to plough again after arvest. This I have found the best mode of cultivaon for corn. I plant my corn about four feet apart ach way, and have from three to five stalks in a hill, r cluster, for I endeavor to keep down the hill, and ave the ground as level as possible. In saving my orn crop, I cut it up, without pulling it from the stalk s usual, and cart it in all together, then husk it out, eaving the husk to the stalk: I lay these near my feedng yard, and throw them into it twice a day: this gives s a large quantity of strong healthy food for the cattle, which serves them all winter, and keeps them in good ondition without any other food; makes a large quanity of excellent manure, and a fine dry feeding yard. As opportunity can be found, we cart marl, fuller's earth, clay, and any good soil that is convenient, into this ard, which being mixed with the stalks, and straw, or ny thing else, penning the cattle on it through the winter and summer, instead of penning on the field, n the common way, we have a large quantity of manure to go out in the fall, and next winter; it is put into he field, in the intermediate rows, between the rows of marl, as far as it will go, and they will get mixed n the cultivation. We also convert the scouring of our ditches, the head-lands of the fields, and all wasteground that we can, into manure, by carting litter from the woods, yard manure, or litter, &c. &c. and mixing with them; so that I can nearly, or quite, now, accomplish making farm-yard and this kind of manure, sufficient to go over my whole hundred acres, annually. For the two last years, I have made more manure than I could accomplish or effect carrying out, though I have manured from ten to twenty acres more than my hundred, each year, with part marl and part farm-yard, but not the whole with both, as I hope to be able to do in future; but it will be necessary to increase my carting force to effect it, and I clearly see, I can raise sufficient manure for the purpose; heretofore I have manured my corn-ground, fifty acres, with marl, and my fallow with part farm-yard manure, and part marl, as mentioned before; so that you will perceive the improvement made on my soil has not been effected by marl alone, but in conjunction with farm-yard manure, clover and plaster, and by making it a point to manure with something all the ground I put into cultivation; so that every time I cultivated a field, that field was improved, and not in any degree impoverished by the cultivation. By this means, and the divine assistance, I have effected that improvement of my farm, which is so very striking to the observation of every person acquainted with it. I can say nothing as to the comparison of crops, before and since my improvement: it has been a progressive thing for many years, and, till I adopted the present plan, I was an experimental farmer, trying every thing I met with in books, or heard of; so that there is scarce any rotation of crops, or mode of cultivation, but what I have tried.

"This I believe, will answer all your questions, except as to the time when I began to use the marl, and how soon I experienced the beneficial effect of it?—being your fourth question.

"In August, 1805, in digging down a bank on the side of a cove, for the purpose of making a causeway, I observed a shelly appearance, which it struck me might improve clay soil; I took some of it immediately to the house, and putting it into a glass with vinegar, found it effervesced very much; this determined me to try it as a manure; accordingly, in September, I carted out about eighty cart loads, and put it on a piece of ground, fallow, preparing for wheat, trying it in different proportions, at the rate of from twenty-seven to about a hundred loads per acre, and the ground was sown in wheat. I could not, myself, be satisfied that there was any difference through the winter and spring, although general Lloyd, who was viewing it with me in the spring, thought he could perceive some difference, in favor of the marl; but at harvest time, the wheat, though not more luxuriant in growth, or better head, was considerably thicker on the ground; and after the wheat was taken off, the ground where the marl had been put was set with white clover, no clover being on the ground on either side of it. The next year, 1806, I discovered it in the drain into the head of the cove, which I immediately ditched, and from the ditch put out seven hundred loads, on the fallow ground. The effect, as to the wheat and clover, was the same, (this was put, for experiment, at the rate of from forty to a hundred and twenty cart-loads per acre,) though the marl was not of the same kind as the other, but more mixed with sand and surface soil, being taken from the low ground, by ditching, and all mixed together. I also tried it on corn ground, spread out as above mentioned, and found the effect immediate, as to the corn; and in the same manner as above described, as to the wheat sown on the corn ground. This induced me to persevere in the use of it, which I have done ever since, adopting the mode I mentioned before, and putting it at first from forty to seventy loads per acre, till I have now come down as low as eighteen or twenty loads per acre, going the third time over the ground with it.

"I believe I have now answered all your inquiries, as well as I can, except as to the average comparison of the past and present crops, which I cannot well do, for the reasons above given, and also that my fields are entirely changed, neither containing the same grounds, nor the same quantity of ground in each; but I believe I shall not be much out of the way, if I say, that I think the soil now capable of producing between two and three times as much, per acre, as it would before I began to use the marl; and though the marl has not solely produced the improvement, yet the improvement would have been far short of what it is, if it had not been for the marl, which has contributed, in a very large degree, towards it; and no small matter in favor of the marl is, that, by the blessing of God on my endeavors, I have, in twelve years, been enabled to improve three hundred acres of ground, to the pitch that these are, and am now in a fair way of increasing in the same ratio that a snow-ball increases as it is turned over.

"I fear you will not be able to read, and hardly to understand, this tedious letter, in many parts; if you can, and it is in any degree satisfactory to you, I shall be compensated, and will cheerfully answer any inquiries, in future, that you may wish to make. The first favorable opportunity, which may probably be by

some friend, in the spring, I propose sending you a small bag of marl, which may be more satisfactory than any description.

JOHN SINGLETON.

*Talbot County, Md. Dec.* 31, 1817.

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## [NOTE H. Page 49.]

### GYPSEOUS EARTH OF JAMES RIVER, AND THE GREEN MARL OF NEW JERSEY, BOTH BELONGING TO THE "GREEN SAND FORMATION."

The passage in the text describing generally the gypseous earth of Prince George county, is left as it stood in the first edition, though much more full developements have since appeared. The first piece on the subject, to which the reader is referred, commences at page 207 Vol. I. of Farmers' Register. It is a full and minute account of the beds in my neighborhood of what I have called *gypseous earth*, and the reasons stated at length for believing it to be the same earth known in New Jersey under the name of *marl*. At that time I had never met with a specimen of the latter substance, and only inferred its qualities and its chemical constitution (in certain respects) from the loose and general, and very unsatisfactory statements previously published respecting that earth. Other subsequent notices in the Farmers' Register, at pp. 272, 572,) present additional facts or reasons in support of the identity of these formations. Afterwards Professor William B. Rogers discovered what geologists call *green sand*, intermingled with many of the bodies of marl near Williamsburg, and in an interesting communication to the Farmers' Register, page 129, Vol. II. in which this discovery is announced, he shows what the green sand is, and that it constitutes the valuable portion of what has been erroneously called marl in New Jersey. Mr. R. had not then seen my earlier account of gypseous earth—but reasoning upon geological grounds he inferred that the true green sand formation would probably be found higher up the country. He has since visited and examined the bed of what I had called gypseous earth, at Coggin's Point, Tarbay, and Evergreen, (in Prince George county,) and has found it to be the green sand formation, as was anticipated, and at the same time, confirmed my opinion of the identity of this earth with the New Jersey "marl." The green sand however in Virginia, so far as yet exposed to examination, is not to compare in richness with the best of New Jersey. The very little as yet known of the practical use, or measure of the value of this earth as manure, is in the paper first referred to above. The length of that piece and of Mr. Rogers', and their having been already published in the Farmers' Register, forbid their being again presented in this place: and in addition, it is expected that Mr. Rogers' more recent examinations will enable him to lay before the public a more correct and full account, which will of course be more interesting than the early views taken when the existing facts were but partially known—and so far as my own investigations went, were known to one who had nothing of the geological knowledge necessary to make proper use of the facts observed.

## [NOTE I. Page 50.]

### THE CAUSE OF THE INEFFICACY OF GYPSUM AS A MANURE ON ACID SOILS.

I do not pretend to explain the mode of operation by which gypsum produces its almost magi benefits: it would be equally hopeless and ridiculous for one having so little knowledge of the successful practice, to attempt an explanation, i which so many good chemists, and agriculturist both scientific and practical, have completely fail ed. There is no operation of nature heretofor less understood, or of which the cause, or agent seems so totally disproportioned to the effect, as th enormous increase of vegetable growth from very small quantity of gypsum, in circumstance favorable to its action. All other known manures whatever may be the nature of their action, re quire to be applied in quantities very far exceed ing any bulk of crop expected from their use. Bu one bushel of gypsum, spread over an acre o land fit for its action, may add more than twent times its own weight to a single crop of clover.

However wonderful and inscrutable the fertil izing power of this manure may be, and admittin its cause as yet to be hidden, and entirely beyon our reach—still it is possible to show reasons wh gypsum cannot act on many situations, where a experience has proved it to be worthless. If thi only can be satisfactorily explained, it will remov much of the uncertainty as to the effects to be ex pected: and the farmer may thence learn on wha soils he may hope for benefit from this manure— on what it will certainly be thrown away—and b what means the circumstances adverse to its ac tion may be removed, and its efficacy thereby se cured. This is the explanation that I shall at tempt.

If the vegetable acid, which I suppose to exis in what I have called acid soils, is not the oxalic (which is the particular acid in sorrel,) at leas every vegetable acid, being composed of differen proportions of the same elements, may easil change to any other, and all to the oxalic acid This, of all bodies known by chemists, has th strongest attraction for lime, and will take it fron any other acid which was before combined with i —and for that purpose, the oxalic acid will let g any other earth or metal, which it had before hel in combination. Let us then observe what woul be the effect of the known chemical action of thes substances, on their meeting in soils. If oxali acid was produced in any soil, its immediate effec would be to unite with its proper proportion of lime if enough was in the soil in any combination what ever. If the lime was in such small quantity a to leave an excess of oxalic acid, that excess woul seize on the other substances in the soil, in the or der of their mutual attractive force; and one o more of such substances are always present, a magnesia, or more certainly, iron and alumina The soil then would not only contain some propor tion of the *oxalate of lime*, but also the oxalate o either one or more of the other substances named Let us suppose gypsum to be applied to this soil This substance, (sulphate of lime) is composed o sulphuric acid and lime. It is applied in a finel pulverized state, and in quantities from half bushel to two bushels the acre—generally no more than one bushel. As soon as the earth i

ade wet enough for any chemical decomposition take place, the oxalic acid must let go its *base* of on, or alumina, and seize upon and combine with e lime that formed an ingredient of the gypsum. he sulphuric acid left free, will combine with the on, or the alumina of the soil, forming copperas the one case, and alum in the other. *The gypsum no longer exists*—and surely no more satisfactory reason can be given why no effect from it ould follow. The decomposition of the gypsum as served to form two or perhaps three other substances. One of them, oxalate of lime, I suppose be highly valuable as manure: but the very nall quantity that could be formed out of one or ven two bushels of gypsum, could have no more sible effect on a whole acre, than that small uantity of calcareous earth, or farm-yard manure. he other substance certainly formed, copperas, is nown to be a poison to soil and to plants—and um, of which the formation would be doubtful, I elieve is also hurtful. In such small quantities, owever, the poison would be as little perceptible s the manure—and no apparent effect whatever ould follow such an application of gypsum to an cid soil. So small a proportion of oxalic acid, or ny oxalate other than of lime, would suffice to ecompose and destroy the gypsum, that it would ot amount to one part in twenty thousand of the oil.

Why gypsum sometimes acts as a manure on cid soils, when applied in large quantities for the pace, is equally well explained by the same theory. If a handful, or even a spoonful of gypsum is ut on a space of six inches square, it would so uch exceed in proportion all the oxalic acid that ould speedily come in contact with it, that all vould not be decomposed—and the part that continued to be gypsum, would show its peculiar powrs perhaps long enough to improve one crop. But s tillage scattered these little collections more qually over the whole space—or even as repeated soaking rains allowed the extension of the attractive powers—applications like these would also e destroyed, after a very short-lived and limited ction.

Soils that are naturally calcareous, cannot contain oxalic acid combined with any other base than me. Hence, gypsum applied there, continues o be gypsum—and exerts its great fertilizing power as in the counties of Loudoun and Frederick. But ven on these most suitable soils, this manure is said ot to be certain and uniform in its effects—and of ourse more certain results are not to be looked for vith us. I have not undertaken to explain its occasional failures any more than its general success, on the lands where it is profitably used—but only why it cannot act at all, on lands of a different kind.

The same chemical action being supposed, explains why the power of profiting by gypsum hould be awakened on acid soils after making hem calcareous—and why that manure should eldom fail, when applied mixed with very large uantities of calcareous earth.

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## [NOTE K. Page 61.]

### ESTIMATES OF THE COST OF LABOR APPLIED TO MARLING.

Before we can estimate with any truth the expense of improving land by marling, it is necessary to fix the fair cost of every kind of labor necessary for the purpose, and for a length of time not less than one year. We very often hear *guesses* of how much a day's labor of a man, a horse, or a wagon and team, may be worth—and all are wide of the truth, because they are made on wrong premises, or no premises whatever. The only correct method is to reduce every kind of labor to its elements—and to fix the cost of every particular necessary to furnish it. This I shall attempt: and if my estimates are erroneous in any particular, others better informed may easily correct my calculation in that respect, and make the necessary allowance on the final amount. Thus, even my mistakes in the grounds of these estimates, will not prevent true and valuable results being derived from them.

The following estimates were made in 1828, according to the prices of that year. I shall make no alteration in any of the sums, because there is no considerable difference at this time, (January 1832,) and the least alteration would make it necessary to change the after calculations founded on them. But no one estimate will suit for years of different prices. If any one desires to know the value of labor when corn (for example) is higher or lower, he must ascertain the difference in that item, and add or deduct, so as to correct the error.

*Cost of the labor of a negro man in 1828.*

| | | | |
|---|---|---|---|
| Hire for the year, payable at the end, - | | | $38 00 |
| Food—19½ bushels of corn at 40 cents, - - | 7 80 | | |
| Add 10 per cent. for waste in keeping, | 78 | | |
| Meat and fish, &c. | 9 00 | | |
| | | $17 58 | |
| Interest for one year on $17 58, paid for food, - - | | 1 05 | |
| | | | 18 63 |
| Clothing—6 yards coarse woollen cloth, at 50 cents, - | | 3 00 | |
| 12 yards cotton, for summer clothes and two shirts, at 12 cents, - | | 1 44 | |
| Blanket at $1 50, once in two years—yearly, - | | 75 | |
| Shoes and mending, - | | 2 50 | |
| | | | 7 19 |
| Taxes—State, 47 cents—county 47—poor 33—road, suppose 1 dollar, - - - | | 2 27 | |
| His share of expense of quarters, fuel, and sending to mill, - - - - | | 4 50 | |
| Nursing when sick, (exclusive of medical aid,) - | | 1 50 | |
| | | | 8 27 |
| | | | $72 09 |
| Add 20 per cent. on the whole of the above for cost of superintendence, waste, wanton damage to stock, tools, &c., and thefts, | | | 14 41 |
| Total expense per year, | | | $86 50 |

| | |
|---|---|
| Time lost—Sundays and holydays, | 58 days |
| Bad weather and half holydays, | 20 |
| Sickness, | 10 |

From 365, deduct 88, leaves 277 working days:

whichmakes the cost of each working day 31¼ cents.

*Remarks.*

The hire was fixed at the average price obtained that year for ten or twelve young men hired out at the highest bids, for field labor. According to our established custom, all the expenses of medical attendance, and loss of time from the death of a slave occurring when he is hired, are paid, or deducted from the hire by the owner—and therefore are omitted in this estimate. By supposing the slave to be hired by his employer, instead of being owned, the calculation is made more simple, and therefore more correct.

*Cost of the labor of a negro woman.*

| | |
|---|---|
| Hire for the year, - - - | $10 00 |
| Food, - - - - - | 12 95 |
| Clothing, blanket, and shoes, - - | 6 50 |
| Taxes, quarters, fuel, mill, nursing, &c,. | 7 19 |
| Add 20 per cent. as before, for superintendence, &c., - - - | 7 53 |
| Total yearly cost, | $44 67 |

Suppose lost time, 108 days, leaves working days 257, at 17⅓ cents for each.

Nearly all the women who are usually hired out, are wanted by persons having few or no other slaves, as cooks, or for some other employment at which they are more useful than at field labor—and their price is nearer fifteen dollars in these cases. But when there is no demand for such purposes, women for field labor will not bring more than ten dollars.

A boy of thirteen or fourteen would hire for more than the foregoing estimate of the hire of a woman, but would not lose half the time from sickness and bad weather, and therefore may be supposed to cost the same per day, or seventeen and one-third cents. A girl, fifteen or sixteen years, for similar reasons, may be put at the same price.

*Cost of the labor of a horse.*

| | | |
|---|---|---|
| First cost of a good work horse, $80 00 —supposed to last five years at work, makes the yearly *wear*, - - | $16 00 | |
| Interest for one year on $80 00—$4 80 —tax, 12 cents, - - - - | 4 92 | $20 92 |
| 20 bbls. of corn at $2 00—3,500 lbs. of fodder at 50 cents the hundred, - | $57 50 | |
| Add 10 per cent. for waste in keeping, | 5 75 | 63 25 |
| Interest on $63 25, for one year, - | $3 79 | |
| Share of yearly expense for corn-house, | 47 | 4 26 |
| Total yearly cost, | | $88 44 |

Lost time, 98 days, leaves 267 working days, at 33 cents.

A mule eats less corn than a horse, but more hay, and lives longer—and may be considered as costing one-fifth less—or yearly cost—$70 00—and daily, 26½ cents.

A tumbril for marling, will cost when new, $25 00

| | |
|---|---|
| It will last two years, or (what is the same thing) if that sum will pay for all repairs, for two years—its wear per year, is | $12 |
| Interest on $25 00 for a year, - - | 1 |
| Cost per year, | $14 |

And at 267 working days—cost per day five cents.

In the estimate of the cost of horse labor, n charge is made for attendance, because that part of the labor of the driver, and forms part his expense. No charge is made for grazing, be cause enough corn and hay are allowed for ever day in the year—and when grass is part of h food, more than as much in value is saved in h dry food. No charge is made for stable or litte as the manure made is supposed to compensa those expenses.

It may be supposed that the prices fixed f corn, and fodder or hay, are too low for an averag Such is not my opinion. The price is fixed at th beginning of the year, when it is always compara tively low, because it is too soon for purchasers keep shelled corn in bulk, and the market is glu ted. Besides, the allowance for waste during th year's use (10 per cent.) makes the actual pric equal to two dollars and twenty cents on July 1s The nominal country price of corn in January, almost always on credit—and small debts for co are the latest and worst paid of all. The farm who can consume any additional portion of hi crop, in employing profitable labor, becomes h own best customer. The corn supposed to b used, by these estimates, is transferred on the fir of January, without even the trouble of shellin or measuring, from A. B. *corn-seller*, to A B. *marler*, and instantly paid for. Two dolla per barrel at that early time, and obtained with little trouble from any purchaser, would be a bett regular sale, than the average of prices and pa ments have afforded for the last eight years.

COST OF MARLING,

*Founded on the foregoing estimates of the cost labor.*

From the beginning of November 1823, to th 31st of May 1824, a regular force, of two hors and suitable hands, was employed in marling Coggin's Point, on every working day, unless pr vented by bad weather, wet and soft roads, some pressing labor of other kinds. The san two horses were used, without any change, an indeed, they had drawn the greater part of all th marl carried out on the farm, since 1818. Th best of the two was seventeen years old—both middle size, and both worse than any of my oth horses, which were kept at ploughing.

The following estimates were made on a co nected portion of this time and labor, and up my own personal observation and notes of th work, from the beginning to the end. It was ve desirable to me, to know the exact cost of som considerable job of marling, attended with certa known difficulties, and on any particular mode estimating the expense: for although the san degree of difficulty, and of cost of labor, mig never again be met with, still, any such estima would furnish a tolerable rule, to apply, in a mod fied form, to any other undertaking of this kin

ıese estimates may be even more useful to other ırsons—as they will serve generally to prove at the greatest obstacles to the execution of this ıprovement, are less alarming, and more easily ercome, than any inexperienced persons would ppose.

Both these jobs were attended with uncommon fficulties, in the unusual thickness of the super-cumbent earth, compared to that of the fossil ells worth digging, and on account of the dis-nce, and amount of ascent to the field. The st job was so much more expensive than was ıticipated, that it may perhaps be considered as a ilure—but as the account of its expense had en kept so carefully, it will be given, just as if ore success and profit had been obtained. This ork was commenced April 14th, 1824. The bed marl for the upper six feet of its thickness, is y and firm, though easy to dig, and rich. It has ı average strength of $\frac{45}{100}$—the shells mostly ılverized, and the remaining earth more of clay an sand. After being carried out, the heaps ppear, to a superficial observer, to be a coarse ose sand. Below six feet, the marl became so oor as not to be worth carrying out, and was not sed except when the distance was very short. Its rength was less than $\frac{20}{100}$. The bed at first was xposed on the surface, near the bottom of a steep ll-side—but as a large quantity had been taken ıt, and several successive cuts made into the ce of the hill, some years before, the covering ırth was increased, on the space now to be clear-l, so as to vary between eight and sixteen feet, ıd I think averaged between eleven and twelve. The situation of the marl and road required that a ear cartway should be made as low as the in-nded digging: and therefore nearly all of the ırth was to be moved by a scraper, and was ırown into the narrow bottom at the foot of the ill. This earth served thus to form an excellent ıuseway across the valley, which made part of ıe road in the next undertaking. All this marl ıns horizontally, and the layers of different qual-ies are very uniform in their thickness. The reater part of the covering earth is a hard clay, r impure fuller's earth, which was difficult to dig, ıd still more so for the scraper to take up and re-move. Part was thrown off by shovels, and erved to increase a mound made by former ope-ations, within the circle around which the scraper as drawn.

*Labor used in digging and removing earth.*

| | |
|---|---|
| days' labor of 9 men, at 31¼ cents each, - | $11 25 |
| 6 women, 2 boys, } at 17⅓ cents, - | 5 58 |
| 1 young girl at 15, and 1 old man at 25, - - - | 1 60 |
| 8 oxen, (the scraper being drawn by 4 half the day, which then rested and grazed while the others worked the other half of the day,)—at 20 cents each, - - - - - | 4 80 |
| dd 80 cents for wear of scraper, hoes, and shovels, - - - - - - - | 80 |
| Total, | $24 03 |

The price allowed for the oxen is much too high r the common work, and so much rest allowed: ut they work so seldom at the scraper, that both the men and the oxen are awkward, and the labor is very heavy, and even injurious to the team.

*Labor of digging and carrying out the Marl.*

Three tumbrils were kept at work on this job and the next, a good mule being added to the regular carting force—and no time was lost from April 20th, to May 31st, except when carts broke down, (which was very often, owing to careless driving, and worse carpentry,) or when bad weather compelled this labor to stop. One man dug the marl and assisted to load; another man loaded, and led the cart out of the pit, until he met another driver returning from the field, to whom he delivered the loaded cart and returned to the pit with the empty one. Of the two other drivers, one was a boy of sixteen, and the other twelve years old—the youngest only was permitted to ride back, when returning empty. The distance to the nearest part of the work (measured by the *chain,*) was nine hundred and two yards, and the farthest one thousand and forty-five: adding two-thirds of the difference to the nearest for the average distance, makes nine hundred and ninety-seven yards. The ascent from the pit, by a road formerly cut and well graduated, for marling, was supposed to be twenty-five feet in perpendicular height—and every trip of the carts, going and coming, crossed a valley, supposed to be fifteen feet deep, and both sides forming a hill-side of that elevation.

When only four and a half feet of the marl had been dug, a large mass of earth fell into the pit, covered entirely the remaining one and half feet of marl, and stopped all passage for carts. To clear away this obstruction would have cost more labor than the remaining marl was worth, and therefore this pit was abandoned. This happened on May 10th, when six hundred and ninety-nine loads had been carried out, and the work done was equal to thirty-six days' work of one cart (by adding together all the working time of each)—which was nineteen and a half loads for the average daily work of each cart, or fifty-eight for the three. The average size of the loads, by trial, was five and a half heaped bushels—and the weight, one hundred and one pounds the bushel. It was laid on at one hundred and four loads or five hundred and seventy-two bushels the acre.

*Labor employed, for* 699 *loads, or* 3680 *bushels.*

| | | |
|---|---|---|
| 2 men at 31¼ cents, - - - | 62½ | |
| 2 boys at 19 cents, - - - | 38 | |
| 2 horses at 33 cents, - - - | 66 | |
| 1 mule at 26½ cents, - - - | 26½ | |
| 3 carts at 5 cents—tools at 3 cents, - - - | 18 | |
| Daily expense, or for 58 loads, | $2 11 | |
| Digging and carting 699 loads at the same rate, - - - - - - | | $25 25 |
| Add the total expense of removing earth, | | 24 28 |
| | | $49 03 |
| Spreading at 31¼ cents the 100 loads, - | | 2 19 |
| Total expense, | | $51 47 |

Which makes the cost per bushel, 1 34-100 cents.
per load, (5½) 7 36-100
per acre, of 572 bushels, $7 66.

This marl was laid on much too thick for common poor land, and one-fourth of the body uncovered was lost, by the falling in of the earth. If one-fourth of the expense of uncovering the marl, was deducted on account of this loss, it would reduce the whole expense nearly one-eighth.

As soon as the carts were stopped in the work just described, they were employed in moving earth from similar marl, across the ravine. The thickness, strength, and other qualities of the marl, on both sides, are not perceptibly different. A large quantity had also been formerly dug on this side, but the land being lower, the covering earth was not more than ten feet where thickest, and the average was eight and a half or nine feet. To make room for convenient working, and a large job, an unusual space was cleared, ten to fourteen feet wide, and perhaps fifty or more long. The shape of the adjoining old pits, compelled this to be irregular. The greater part of the earth was of the same hard fuller's earth mentioned as being on the other side—and the upper part of this was still worse, being in woods, and the digging obstructed by the roots and trees.

*Labor used in digging and removing the earth.*

| | | | | |
|---|---|---|---|---|
| 6 men | 4 days, | at $31\frac{1}{2}$ cents, | $8 | $43\frac{3}{4}$ |
| 1 man | 3 | | | |
| 5 women | 5 | at $17\frac{1}{2}$ cents, | 6 | 24 |
| 1 woman | 1 | | | |
| 2 boys | 5 | | | |
| 1 old man | 2 | 25 cents, | | 50 |
| 2 girls | 6 | 15 cents, | 1 | 80 |
| 8 oxen, for the scraper, as before, each team at rest half the day, 5 days, at 20 cents, - - - - - - | | | 8 | 00 |
| 3 horses and carts, $1\frac{1}{2}$ days, at 38 cents | | | 1 | 71 |
| Add for damages to scraper and other utensils, | | | | 80 |
| Total cost of moving earth, | | | $27 | $48\frac{3}{4}$ |

Enough of the earth was carried by the carts to the dam crossing the ravine, to raise the roads as high as the bottom of the intended pit. The balance was thrown into the valley wherever most convenient. Only a small proportion, perhaps one-third, could be thrown off, without being carried away by the carts, and scraper.

The loads were carried to the same field, and by the same road as from the former digging. The first hundred and ninety-one loads served to finish the piece begun before, of which the average distance was nine hundred and ninety-seven yards: all the balance was carried to land adjoining the former, eight hundred and forty-seven measured yards from the pit.

The loads were ordered to be increased to six bushels, which was as much as the carts (without tail-boards) could hold, without waste, in ascending the hills: but as the loaders often fell below that quantity, I suppose the average to have been five and three-fourths heaped bushels, or five hundred and eighty-one pounds.

The tumbrils were kept constantly at this work, except when some of the land was too wet, or for some other unavoidable cause of delay. All the space which the old pits occupied, and over which the road passed, being composed of tough clay thrown from later openings, and which had never become solid, was made miry by every heavy rain, and caused more loss of time than would usually occur at that season. The same four laborers, and two horses, and one mule, employed as be fore—and their daily work was as follows:—

| | | | |
|---|---|---|---|
| May 13th, Began the new pit | | | |
| 13th, 2 carts all the day, and 1 for 2 hours only, (afterwards otherwise ployed,) - - - | 47 loads. | | |
| 14th, 2 " half the day, then employed otherwise—(1 horse idle) | 21 | | |
| 15th, 3 " - - - - - - | 61 | | |
| 16th, Sunday. | | | |
| 17th, 3 " finished most distant work with - - - - - | 62 | | |
| | | 191 | |
| and began nearest with | 4 | | |
| 18th, 3 " for 4 hours (stopped by heavy rain,) - - - | 22 | | |
| 19th and 20, 3 carts at work elsewhere, on drier land, | | | |
| 21st, 3 " again marling, - - - | 75 | | |
| 22d, rain—no work done by horses. | | | |
| 23d, Sunday. | | | |
| 24th, 1 " at other work. | | | |
| 25th, 3 " again marling, - - | 74 | | |
| 26th, 3 " - - - - - - | 75 | | |
| 27th, 3 " - - - - - - | 72 | | |
| 28th, 3 " - - - - - - | 72 | | |
| 29th, 3 " (shafts of one broken and repaired,) - - - | 64 | | |
| 30th, Sunday. | | | |
| 31st, 3 " until rain at 4 P. M. - | 53 | | |
| | | 511 | |
| | | 702 | |

After this stoppage, the horses were put t ploughing the corn, that the cultivation might b sufficiently advanced to use all the laborers in har vest, which began on the 11th of June. As nea as I could determine by inspection, and a roug cubic measurement, about one-half of the uncov ered marl was then dug and carried out. As th remainder was not dug until August, when I wa absent from home, I have no more correct mean of ascertaining these proportions; and shall ac cording to this supposition charge *half* the actu cost of the whole uncovering of earth, to this sup posed half of the marl which formed this last op eration.

The list of days' work shows that the averag number of loads per day, at eight hundred an forty-seven yards, was twenty-four and a half fo each cart, which made twenty-three and a ha miles for the day's journey of each horse. Th first four days' work finished the farthest piece, which the average distance was nine hundred an ninety-seven yards—but this part of the work wa on the nearest side of that piece, and at less tha that average distance. I shall not make any sep arate calculation for these hundred and ninety-on loads, but consider all as if carried only eight hun dred and forty-seven yards.

| | | |
|---|---|---|
| The daily cost of the laboring force, 2 men, 2 boys, 2 horses, and 1 mule, was before estimated at $2 11—which served to carry out $73\frac{1}{2}$ loads, or 422 bushels. At that rate, (to May 31st,) 702 loads, or 4036 bushels, cost, - - - - - | $20 | 15 |
| Add half the expense of uncovering, (half the marl still remaining not dug,) - | 13 | 74 |
| For spreading, at $31\frac{1}{4}$ cents per hundred loads, - - - - - | 2 | 18 |
| Total cost of 4036 bushels laid on, | $36 | 07 |

Which makes the cost per bushel, 9 mills nearl

| | | |
|---|---|---|
| ıd per acre, at 104 loads, or 598 bushels, | $5 | 34½ |
| -( at 400 bushels, which would have been a sufficient, and much safer dressing | $3 | 57½ |

In 1828, at Shellbanks, a very poor, worn, and ly farm, I commenced marling, and in about ır months, finished one hundred and twenty and half acres at rates between two hundred and ırty and two hundred and eighty bushels per re. The time taken up in this work, was five ys in January, and all February and March, th two carts at work—and from the 5th of Au-st to the 27th of September, with a much strong-force. I kept a very minute journal of all these erations, showing the amount of labor employ-, and of loads carried out during the whole time. would be entirely unnecessary to state here any ing more than the general amounts of labor and expense, after the two particular statements just bmitted. At Shellbanks, the difficulties of open-g pits were generally less—the average distance orter, and the reduced state of the soil, and the ength of the marl, made heavy dressings dan-rous. These circumstances all served to dimin-ı the expense to the acre. The difficulties, how-er, at some of the pits, were very great, owing the quantity of water continually running in, rough the loose fragments of the shells—and al-ost every load was carried up some high hill. aking every thing into consideration, I should ppose that the labor and cost of this large job of arling will be equal to, if not greater, than the erage of all that may be undertaken, and judi-ously executed, on farms having plenty of this eans for improvement, at convenient distances.

*Cost of marling* 120½ *acres at Shellbanks.*

| | | |
|---|---|---|
| eparatory work, including uncovering marl, cutting and repairing the necessary roads, and bringing corn for the team—Digging, carrying out, and spreading 6892 loads (4½ heaped bushels) of marl, - - - | $250 | 38 |
| t the average rate of 57½ loads, or 259 bushels per acre, the average expense was, to the acre, - - - - - - | 2 | 08 |
| To the load, - - 3 cents and 63-100ths, | | |
| And to the bushel, - 0 83-100ths. | | |

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## [NOTE M. Page 62.]

### STIMATE OF THE EXPENSE OF WATER-BORNE MARL AND LIME, FOR MANURE.

The following extracts from different communi-ations to the Farmers' Register present interest-ıg and valuable facts, which show the actual ost incurred in procuring and applying water-orne marl, and comparisons of the cost, and of re-ırns, of the use of marl and lime. To those ho know the two gentlemen whose letters are here epublished, it is superfluous to say that on none ught more reliance to be placed as farmers of ood judgement. Both have had much expe-ience of the use of oyster-shell lime as manure, nd none value it more highly.

To the Editor of the Farmers' Register.

*Charles City, December 2d,* 1833.

"I am sorry to have delayed sending you the es-imate promised of the cost of applying oyster shell lime as a manure: it was however unavoidable. I might have given it before this, on my own responsibility; but preferred to have others of as much experience to assist me in making it.



In the first place then, the cost of shells brought to our landing places, is per hogshead of eighteen bushels, 62½ cts.

| | |
|---|---|
| To cost of getting them from the craft, if very convenient for landing, | 2½ |
| To cutting wood, allowing 12 cords for one hundred hogsheads, | 3 |
| To hauling shells to the wood, or wood to the shells, as may be most convenient, hauling out the shells after burning, slaking, scattering, &c. | 32 |
| | 100 |

Thus making the sum of one dollar the hogshead. To afford then five hogsheads to the acre after burning, (which has been the quantity applied by myself and my brother, on very stiff land,) one third more must be added, as the loss by that process; and I am inclined to the opinion that a fraction more may be added, which will make seven hogsheads, the cost of which I have shown above to be seven dollars. On a lighter soil, four hogsheads are deemed sufficient, which will diminish the expense one dollar. If there is any error in this estimate, I am satisfied that it is in the low rate of charges: and I am confirmed in this opinion by one of my tenants, who is a man of considerable experience, having refused to accept the offer of thirty-five cents per hogshead, as full compensation for all the trouble and expense of liming, save the purchase and delivery of the shells.

*Charles City Jan.* 1, 1834.

"I am now enabled to complete the comparative estimate of the expense of lime and water-borne marl, for manure, which you requested me to furnish. If the statements submitted are not full in every respect, they may at least be relied on so far as they go.

"I commenced regularly to work about the 15th May to transport marl from Coggin's Point to my farm, a distance of fifteen miles by water, and ended on the 25th of December, a period of seven months. I had engaged in the business three hands, two of them at eight dollars per month, and the other a boy worth about two dollars and fifty cents. I purchased a craft, and when provided with all the necessary fixtures for commencing work, the cost was three hundred dollars. On the supposition, that this craft will at the end of ten years be entirely worthless, I will estimate the "wear and tear" or loss of capital therein, at thirty dollars per annum, the average annual repairs at thirty dollars more, and the expense of provisions for the hands at ninety dollars for the year. With these preliminaries, I think I may now fairly make out my account for the transportation of the marl, as follows:

| | | |
|---|---|---|
| To cost of vessel, in "wear and tear" for seven months, | $17 50 | |
| To average expense of repairs, | 17 50 | |
| To average interest on $300, for seven months, | 10 50 | |
| | | 45 50 |

| | |
|---|---|
| Amount brought forward | 45 50 |
| Hire of three hands for seven months, | 122 50 |
| Provisions for seven months, | 52 50 |
| Paid for uncovering marl, and for putting on board a part of the whole quantity, | 70 00 |
| | 290 50 |
| CR. | |
| By 15,000 bushels of marl, at $1\frac{14}{15}$ cents the bushel (very nearly,) | 290 50 |

"This makes the whole cost of the marl, put out at my landing, less than two cents the heaped bushel. The estimate for hauling, scattering, &c. I will leave for you to add; that depends however on the distance; and I can only say, that a single horse cart was fully sufficient to keep way with the craft, a distance of one thousand yards. I think I can safely say, that no one can meet with more difficulties than I have myself encountered in this undertaking; my landing place being so bad, that I have known the hands frequently engaged for a whole week in unloading the craft, because of very low tides; when if the water had been sufficient to admit them to the wharf, they might easily have accomplished the work in half the time. I feel also perfectly justified in saying, that had I been so situated as to have the advantages of a landing place which no tide could interfere with, that five thousand bushels more of marl could have been brought during the seven months.

C. H. MINGE."

"The foregoing estimate may be implicitly relied on, so far as it rests on actual expenditures and operations—and in the items which are necessarily conjectural, we have every assurance of correctness, that can be furnished by the practical and business-like habits which characterize the writer. But as the estimate is not completely carried out, we will attempt to supply the deficiency, and will add some observations on the comparative expense of water-borne marl and lime.

According to the estimates of the cost of labor used for marling given in the *Essay on Calcareous Manures*,

| | |
|---|---|
| A horse for a year's work, and including every expense, costs | \$88 44 |
| Boy to drive, | 44 67 |
| Cart and tools, | 14 00 |
| | \$147 11 |

| | |
|---|---|
| "At which rate, the carting of 15,000 bushels of marl 1,000 yards, from the landing to the field, in seven months, cost | \$85 81 |
| Spreading the loads, in the field, at ten cents the 100 bushels. | 11 50 |
| | \$97 31 |
| Cost of transportation, &c. before stated, | 290 50 |
| Whole expense of applying 15,000 bushels, | \$387 81 |

Or rather more than $2\frac{1}{2}$ cents the bushel.

"This estimate includes no charge for the marl, as none had been made. If half a cent was added for this, it would increase the cost to about thr cents the bushel. On the other hand, the pri paid for hire was unusually high, as free han only were employed, and only such as could relied on. The difficulty of obtaining this ma was very considerable, on account of the gre thickness of superincumbent earth to be remove Many other causes of difficulty and loss were e countered by Mr. Minge (all serving to increa his estimate to what it exhibits,) on account of having commenced a perfectly new business, every part of which, he and his laborers we alike strangers. But without making any dedu tion for any of the peculiar difficulties which a tended the operations, and supposing half a ce a bushel, a fair price to pay the owner of the ma the entire cost will be counted at three cents t bushel. By the preceding estimate the entire co of lime, at \$1 the hogshead of shells was $5\frac{10}{18}$, s $5\frac{1}{2}$ cents the bushel. Now we will compa values.

"Oyster shells are not pure carbonate of lim They contain a portion (how much we know no of animal matter, destructible by fire, and whi is entirely lost in burning the shells. Whatever this proportion of animal matter, it ought to deducted from the weight and value of the shel but not knowing this proportion, the shells will here estimated as if they consisted of pure carb nate of lime. The marl, carefully averaged, a analyzed, was found to contain 61 per cent. of ca bonate of lime.

"A peck measure of oyster shells, which h been well washed and dried, heaped about inches, (supposed to be fully equal to selling me sure,) weighed $16\frac{3}{4}$ pounds. The marl (an av rage of the whole thickness of the bed,) dried pe fectly over the fire, and pounded, and pressed the hands only in the same peck measure, weigh $20\frac{1}{2}$ pounds, even, and 24 pounds heaped. T measure and weight were supposed to be fixed correct instruments—but the same were used, a at one time, so that the relative weights, at lea are correct.

| | |
|---|---|
| One hundred bushels of oyster shells, weighing lbs.=6,700 lbs. making of carbonate of lime the same, | lbs. 6,7 |
| One hundred bushels of dried marl, weighing 96 lbs. = 9,600 lbs. and contain of carbonate of lime, | lbs. 5,8 |

Thus the marl which costs only a small fracti over one-half as much as the total expense of t shells, contains about 6 sevenths as much of pu calcareous matter.

"But one of these manures is applied mild, or the form of carbonate of lime, and the other caustic, or quicklime: and some may doubt whet er an additional value is not gained by the burni of the latter. This, we leave to others to deci In most cases, in this climate, we should consi the causticity of lime as more likely to be injurio than beneficial. The minutely divided state quicklime, however, certainly enables every par cle to come into immediate operation; whereas might require two or three years before the f benefit of marl could be obtained. This som what slower action at first, is the only reason w marl should not be rated, according to its prop tion of calcareous matter, full as high as lime.

"These results, which we have arrived at

ite a different route, do not differ materially from ose obtained by Wm. B. Harrison, Esq. (No 7, 396, Farm. Reg.) from his practice and expe- nce. He applied burnt but unslaked shells, at the te of seventy bushels, and marl at 140 bushels the re; on adjoining and equal land, and found the ops of the first and second years equally increased both manures, but that of the third year much tter on the marled part. To make seventy ishels of burnt and unslaked shells, 108 would be quired, (according to Mr. F. Lewis' estimate, ol. I. p. 19, Farm. Reg.) so that according to the regoing mode of calculation, Mr. Harrison's ap- ications were at the rate of 108 bushels of oys- r shells to the acre, and 140 of marl. His marl as from a bed of quality similar to that used by Ir. Minge, but was mixed with much worthless rth, and was transported at heavier expense.

"This comparative estimate of values, has been ade to apply to a particular body of marl, be- ause the actual labor was there employed, and it as desirable to estimate as much as possible by cts, rather than on conjecture. But there are oubtless many bodies of marl on tide-water, ther richer, or more accessible, or perhaps pos- ssing both those advantages in a higher de- ree."—*Ed. Farm. Reg.*

*Charles City County, Feb. 4th, 1835.*

"I have delayed much longer than I intended, giving you an estimate of my last year's work the transportation of marl. The pressure of usiness which is usual with me at the commence- ent of every year, must be my apology.

"Our work began on, or about, the 25th of Iarch, and ended on the 24th December, a period f eight months. The labor employed was the ame as the preceding year two men and a boy, ith the exception of the first two months, when e assistance of the boy was unavoidably with- rawn. The wages of the men were eight dol- rs per month, and the boy's three dollars and ity cents. The quantity of marl transported was eventeen thousand bushels. Our business was ecessarily suspended for twenty days in repair- g our frail bark, in the month of October. The istance is fifteen miles. I shall not attempt to ive any estimate of the expense of hauling from y landing, and scattering the marl, as you have already at hand, and can easily add it if you hink it necessary.

| | | |
|---|---|---|
| To hire of laborers, - - | | $152 50 |
| Food for laborers, - - - - | | 60 |
| Repairs of vessel, - - | | 40 |
| Interest on first cost and fixtures, | | 18 |
| | | $270 50 |
| By 17000 bushels of marl at 1 $\frac{6}{10}$ cents per bushel, | $272 | 272 |
| | | 1 50 |

"Thus showing that the expenseof transportation lone falls under one cent and six-tenths per ushel. It seems to me wonderful, that so much reference should be given to oyster shells, by hose convenient to water. I have used both, and greatly prefer the marl; first as being the cheapest —and secondly, as yielding a more immediate return for the labor, which is one of the most desirable objects to be attained in all improvement. I am still laboring under great disadvantage in regard to the landing of the marl on my shore. Nearly one-third of each load requires to be shift- ed to a smaller vessel, to enable the larger one to reach the wharf with the remainder, which still convinces me that the digging and water carriage could be reduced, under more favorable circum- stances, to one cent per bushel.

C. H. MINGE."

"According to the previous estimate of the cost of the preceding year's labor, the carting of these 17,000 bushels of marl from the landing to the field, (1000 yards) and spreading, would amount to $110 28—to which add the cost above stated for digging and water carriage $270 50, and it appears that the total cost was $380 78, or not quite $2\frac{1}{4}$ cents the bushel. These facts well de- serve the attention of all land-holders on naviga- ble water, who have not marl on their own farms. The marl this year was brought from a different bed (in Surry) recently bought by Mr. Minge and others, to obtain marl for transportation, but at as great a distance as that which he worked in 1833." —*Ed. Farm. Reg.*

*Upper Brandon, Prince George Co. Va., Nov.* 1, 1833.

"The two following experiments to test the comparative value of lime and marl, were made on adjoining pieces of land of the same original quality, and previously manured from the same heap. The soil on which the first experiment was made, was a fine loam, rather stiff. I applied seventy bushels of unslacked lime per acre, and one hundred and forty of the marl, or two mea- sures for one. The land was put in corn, succeed- ed by wheat, and is now in clover. The two former crops were equally and manifestly benefit- ed by the calcareous matter, but the clover exhi- bits a much more flourishing appearance on the marled part, although it is very fine where the lime was applied.

"The land on which I tried the second experi- ment is now in corn. The soil is light. The quantities of lime and marl, and the previous im- provement the same as before. The corn on the marled part is equally as good as where the lime was used, and strikingly better than on the ad- joining land which had received the same dressing of putrescent manure.

"The marl used was brought by water 12 miles; and I applied only 140 bushels per acre, because the cost of this quantity, and of 70 bushels of un- slacked lime, was found to be nearly the same, and from the tried efficacy of the lime, I well know, that, if the effect proved to be equally great, I could extend the use of it to great advantage. Contrary to my expectation, the results of the ex- periments stated, fully establish the fact that the 140 bushels of marl are at least as efficacious as half the quantity of lime. You ask how much the crop was increased by the marl? I regret that I did not ascertain by measurement, and can- not therefore say precisely—but it may be confi- dently affirmed, that the increase of the first crop of corn and wheat will repay the whole cost of the marling, and the land will be left permanently improved.

WM. B. HARRISON."

## [NOTE N. Page 65.]

### PROOFS OF THE EFFECT OF CALCAREOUS EARTH IN PREVENTING DISEASE.

"The perusal of the "Supplementary Chapter" to the Essay on Calcareous Manures, (in No. 2 of the Farmers' Register,) and the inquiry with which it closes, as to the effects of marl in purifying the air and contributing to healthfulness, induces me to mention a case somewhat in point. If I can give you no very satisfactory information, I may be the cause of eliciting it from others.

"The streets of Mobile are generally unpaved, and as a substitute for stone or gravel, which are not to be obtained, shells, (which have long been untenanted,) are strown over the carriage ways and side walks to the depth of several inches. These soon become a firm mass, and form a smooth surface, so as to resemble a Macadamized road. The streets have a remarkably neat and clean appearance, and are much more pleasant than the paved ones.

"The shells, which are of various kinds, generally small, are raked up in great quantities in the shallow lakes, and brought to the city in large lighters.

"Mobile is much more healthy now than it was before this plan of improving its streets was adopted. It was proposed to "shell" some of the streets of New Orleans, but whether it was carried into effect, I am unable to inform you. The suggestion you have made may call the attention of its citizens to the subject. M." *Farmers' Register, Vol. p.* 152.

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"In the 3d No. of the Register, a writer, under the signature of "M," has told us, that since the town of Mobile was paved with shells, it has become much more healthy. This is strong probable testimony in favor of the principles advanced. A few days ago, and before I saw the third No. of the Register, I saw a near connexion, who has just returned from a settlement which he has made on the Black Warrior, about 50 miles below Tuscaloosa. He spoke of the fact that Mobile had become much more healthy within a few years, without, however, assigning any cause. He also represented a very large portion of that country, between Tuscaloosa and Mobile, as calcareous, and abounding in shell marl, [or soft limestone.] He says, the country, if not more healthy, is certainly not more sickly than this part of Virginia,* and that it appears to be generally understood there, that the marl preserves it from disease. As one evidence of the fact, that the country owed its healthiness to the marl, he stated that the more northern parts of the state, where that deposite was not found, the country was more sickly."—*Farmers' Register, Vol. I. p.* 214.

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"The fine rich prairie soil is calcareous manure itself, tempered by nature with the most happy combinations of silicious earth and vegetable mould: and the quality of the soil rises just in proportion to the justness of these combinations. In some places the calcareous formation approaches quite to the surface, and makes what are called "bald prairies." These sometimes cover as much as an acre, perhaps more, perfectly white and thick; but they are rendered productive by the addition of sand, and by ploughing—(being generally soft enough to yield to the plough—) and as soon as grass and weeds, or a crop of corn or cotton can take root, and leave a vegetable deposite, these bald plains grow black, or at least of a much darker shade. It is astonishing with what facility vegetable substances are decomposed in the prairies, and rendered subservient to the improvement of the soil. There is another fact connected with this part of the subject, that strongly corroborates your views regarding the healthy actio of calcareous earths on putrescent matter, containe in a "Supplementary Chapter," on that subject, in th second No. of the Farmers' Register. This fact i that the prairies have proven to be the healthiest par of the state—notwithstanding the water is to all ap pearance bad, and is unquestionably very unpleasa to the taste of those most used to it. The calcareou formation forms a substratum for the whole extent o the prairie country, and is accessible at the banks o every creek and gulley, and I have discovered it i various places at considerable distances from the pra ries. In most instances it is white as chalk—some times it is blue—and in all cases it abounds with sma sea shells almost decomposed. By cutting it with saw and planing it, (as is often done for building pu poses,) you see the lines, or sections, of the shells: b breaking it, you often see the impression of the su faces of the shells. It grows harder by dry exposur but it is not very good for building. It absorbs muc water and scales by freezing. With sufficient heat, turns to lime, which is good for building, but is to coarse and dark for plastering. The best lime is mad from that which has been exposed perhaps for ages t the action of the sun and air; and that kind presen itself in various places, and in large tracts, exhibitin a very singular, craggy appearance, resembling larg bones of animals, and other grotesque shapes."—*Far mers' Register, Vol. I. p.* 276.

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Extract from the Southern Agriculturist of Aug. 1833.

"I have only seen the prairies of Alabama, in th counties of Montgomery and Lowndes, and have trie to ascertain the composition of the soil, and the effec produced on it by heat, drought, and moisture, so fa as connected with their productions. The prairie mean the lime lands, and cover a large portion of th surface of the middle parts of that State, and are d vided into the wooded and bald, (or unwooded prairie which are so interspersed, that in one thousand acre together of the most wooded, there will be from one third to one-fifth of bald prairie, and in the most bald a similar proportion of wooded prairie. To speak ge nerally, the prairies are healthy, high, dry, and ver undulating, presenting but few levels and no savan nahs; the hills bald or unwooded, and covered with dense growth of grass and weeds, furnishing coars but excellent pasturage; the sides of the hills, begin ning at about one-half of their declivities, with the in tervening valleys (there called slues) wooded, wit the soil of jet black color, which sometimes extend over the whole hill, though very often the bald par are the color of lime; the crown of many of the hil to the space of half an acre, covered with the pu lime rock in lumps, which, on calcination, makes e cellent lime, and in great abundance. The sides o the hills and slues are very properly considered the be lands as to fertility, durableness and exemption fro rust. The black soil, and that growth which show rich land here, is considered the best, and the close c stiff soils, if such a term can properly be applied lands so very loose, are to be preferred as being mo certainly free from the rust, a disease to which cotto is very liable in the bald, and in some kinds of th wooded prairie, after long use.

"There are also some prairie swamps, or levels o considerable width, very rich indeed, and very closel covered with a dense growth of canes, (much of the more than thirty feet high) and a heavy growth o large timber. These lands, as well as some other often present uniform inequalities over their gener levels, resembling the lairs of large animals. The In dians say they are buffalo beds; they are called th hog-bed lands, and are considered the evidence of su perior quality. But small portions of these lands hav fallen under the stroke of the axe, from their difficult of clearing, and being liable to be overflowed by th

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* Nottoway county—part of the middle and hilly region of Virginia.

uantity of water which is precipitated on them from he very broken country about them.

"This embraces the general character of the surface f the country. The soil presents on and below its urface, oyster and other sea-shells, and the petrified emains of fish, and shows evidently that it was once overed by the ocean. It is for many feet in depth a nass of rotten limestone, in all the various situations 1 which it has been placed by the chemical action of eat and moisture, and by the decomposed vegetable natter. Those soils are best where there is the most egetable matter: hence the woodlands that pay for neir tenancy in the soil the annual contribution of neir leaves, are better than the bald prairies which receive only a scanty contribution from their decayed rasses. The soil is a powder which dries quickly on s surface for an inch or two, and in dry weather is all ver in small cracks, and looks very dry and husky and nfit for vegetation; but below its surface two inches, r below where the plough has reached, there is a per-etual moisture. The soil works up under the fingers vithout grit, and very much like putty. From a asual observation of the black light inland swamps of ne lower country of this state, I would say, there was nuch resemblance between them as to appearance, ut to appearance only. This quality in the soil auses the prairie to bear drought surprisingly, and ood crops of cotton and corn are made on them, in easons that cut short the product of other lands.

"This fineness of soil prevents the percolation of nuch water through it: hence, in the rains of winter, vhen but very little evaporation is going on, it makes he worst roads imaginable; so much so, that it is a naterial deduction from the value of any plantation, hat should be more than ten miles from navigation.

"This fineness of soil, which prevents its absorp-ion of water to any depth, I think the cause of ano-her mischief. It prevents the gradual feeding of the vells and springs, and in dry summers they go dry to n extent on some few plantations, to require water to e hauled to the people in the fields, and in extraordi-nary years to be hauled to their settlements. It is ery common for stock to suffer much for the want of vater. So soon as the warmth of spring is felt, and evaporation begins, the roads improve surprisingly and become good, and the lands become dry; and when once well ploughed up in the spring, become as light s an ash-heap, or as lime itself, which it is, and no subsequent weather ever puts them out of order, ex-cept for a day or two, from some great rain. You can generally plough the day after a hard rain.

"The soil being so loose and light, makes it very lia-ble to run its surface off with every rain, and I do not hink that horizontal ploughing would save it, nor the neans usually considered effectual here. I have tried cotton stalks, and bushes, up a slope without effect, that would have been sufficient here.* You cannot ditch with the spade in the prairie: you would make as much and very similar progress in a barrel of pitch. With all this liability of your lands to wash, it will be a long time before you will lose its soil, for it is very deep. I find the opinion entertained by intelligent gentlemen, that the fertility may be restored by the chemical action of the sun and air without putting ve-getable matter there. This looseness of soil and want of retention of moisture at the surface, during the crop season, makes the prairies the kindest and the easiest and to work. I would prefer to make a crop on them n an ordinarily good year, to preparing for one here.* You can very well cultivate one-fifth more land to the aborer, and gather two-thirds more of cotton. The reason why you can gather more, is, because the cotton pod in that soil and climate matures perfectly, and opens so wide, that the whole contents of the boll comes out at a touch of the fingers; when here, it is drawn out at two pulls, and sometimes a third; another reason is, that you commence picking about a fortnight earlier than here, and this time in the long days of August, is equal to one bale, of our weights, to each laborer: and yet another reason is, that knowing that the amount of the crop depends on the gathering, all other works are so arranged as not to interfere with it.

"I think the country more healthy than this, owing in part to its being more high, dry, and broken, and more under the strong influence of the trade winds; but there must be a farther reason, because I have seen local causes enough to produce sickness here, in spite of the general causes of salubrity, that did not produce it there. Families reside with security on their prairie plantations all summer, in the midst of extensive clearings of rich land. I think it must come from some purification of atmosphere arising from the immense quantity of lime on and near the surface of the soil. The other lands in that country under similar circumstances, are not more healthy than here.* The waters on the prairie do not corrupt; it is disagreeable to the taste, and both cathartic and diurectic in its effects on a new settler, but after a few weeks he becomes reconciled to its taste, and many prefer it to other good water."

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*Mobile, Aug.* 28, 1833.

"Agreeably to my promise, I proceed to detail to you some particulars about the former situation and present condition of this place, in regard to its health, as connected with the system of shelling the streets, and in support of the position assumed in a '*Supplementary Chapter to the Essay on Calcareous Manures,*' recommending calcareous earths as promotive of health and cleanliness in cities and towns—(p. 76, Farmers' Register, No. 2.)

"I settled in Mobile in 1819, and have resided here ever since. Mobile is situated at the head of Mobile bay, just where the river of the same name enters it. The plain on which the city stands extends back five miles, and covered by a pine forest. The region of hilly pine woods then sets in, and affords fine healthy summer retreats. Summer retreats have been formed over the plain, quite from the city to the hill land; and they prove to be healthy. In 1819, Mobile was a small wooden built town—the streets narrow and deep with light sand, except under the bluff, (which was eight to twelve feet above the level of the river,) where the streets were muddy—the tide ebbing and flowing over a margin of marsh from 4 to 600 feet wide, the edge of the marsh next the bluff at all times wet springy land. The rapidly increasing trade of the place, early drew those engaged in it towards the river, and soon covered the flat with store-houses, built on lots so badly filled up, that water stood under all of them, without exception—under some 6 inches, some 1 to 2 feet: and encroachments were made quite into the water, by laying timbers horizontally, to give sufficient elevation. High tides brought in floating logs—marsh grass—and all small substances that were borne on the waves, depositing them in the streets and over the flat. There were only one or two streets at all filled in this flat, and they were very partially done. My first visit was in July, 1819, about the middle of the month: then it was healthy. About the last of that month, a violent S. E. storm cast an immense quantity of trash and filth over the flat, and a long drought followed, with prevailing north winds, which kept the water of the bay unusually low. The place that summer was visited with the yellow fever, to the extent of a pestilence. In 1820, there was no prevailing epidemic, though the place could not be said to be healthy; perhaps there were some cases of yellow fever. I was absent three or four months this year on business. In 1821, there was less sickness than the previous year. That year, the government sold the site of Fort Charlotte, (now near

* In South Carolina.

* In South Carolina.

the centre of the city,) and the citizens thus came in possession of an immense quantity of material for filling up. The fort was a very strong Spanish built one, with walls 20 to 25 feet high, and 15 to 18 feet thick, made of brick and stone, strongly cemented with mortar of shell lime. It had an outer wall, and a glacis surrounding the whole, of pure earth. All this, during the latter part of 1821, and in 1822 and 1823, was carted and spread over the flat, together with an immense quantity of earth taken from the back parts of the town, which went very far towards filling up the flats above high water. But this filling was put in the streets and lots, and the foundations of houses already built, were thus made lower than the surrounding land. In 1824, similar improvements were carried on, and up to (and including) that year, there was no epidemic diseases: but bilious fevers were common, and the place was counted unhealthy.

"In 1825, similar improvements went on, and the place was healthy up to the 25th of June, when a wet spell occured that lasted through the most of July—showery, with intervening hot suns. That year, the old burying ground, which is now in the heart of the city, and interments in which had been discontinued the previous year, being the property of the Catholic Church, was laid off in building lots, and let out on long leases; and many who had friends and relatives buried there, were permitted to disinter them, and remove them to the new grave yard. This operation was carried on during the months of June and July, and the old graves were left open to the influence of the rain and hot sun, to evolve the noxious effluvia that had been engendered by the decomposition of the bodies they had contained. Most of the subjects that were removed were of those who had died in 1819 and subsequently; and I doubt not the miasmata that were exhaled partook of the nature of that which produced the disease of which the subject died—it may be it was identical. This year the yellow fever raged again like a pestilence, and, unless I have already assigned the real cause of the fatal sickness of this year, I am at a loss how to account for it from any local cause that would not have operated as powerfully any previous or subsequent year, anterior to the shelling system. It is to be admitted, that the deep loose sandy streets, and back yards, would serve as recepticles for an immense amount of animal and vegetable matter, thrown out from kitchens and shops, which, in a dry time, was trodden in and hid, and yet the substance remain to be operated on by heat and moisture: and that the effluvia thus created would co-operate with the cause before assigned. There is another collateral cause worthy of notice, that exposed many a poor creature to the influences of the general causes of sickness, and no doubt accelerated its progress. That year is remembered as the "gambling year." The legislature, by careless legislation, in a very laudable zeal to suppress that pernicious vice, by a sweeping clause so framed a law, as that it admitted a construction to license gambling, instead of suppressing it. Many gambling houses were opened under a $1000 license, as public as taverns; and such scenes of dissipation have rarely been witnessed in any country. Exposure to night air, loss of sleep, loss of fortune, loss of character, drunkenness and debauchery, (all fruitful exciting causes,) no doubt had their full effect in swelling the list of mortality.

"In 1826 and 1827, many brick buildings were in progress, and the sites of them exposed by removal of the old wood buildings. This, with the general absence of cleanliness produced by the capacity of sandy streets to retain filth, as remarked above, caused sickness these two years. There were several cases of yellow fever in both years; but nothing to be compared with 1825. In October, 1827, a fire occurred that swept the whole business part of the town, and hardly left a house standing, wood or brick, in all the flat below the bluff. The legislature, at the next session, which commenced soon afterwards, passed a law prohibiting the building of any other than fire-proo buildings within certain limits that included the busi ness part of the town; and here begins a new era i the history of Mobile. In 1826, a brother of mine who is a physician, then residing here, urged the im portance of improving the health of the city, (whic he deemed perfectly practicable,) both through th medium of the press, and in conversations, upon a suitable occasions. Nothing was done while he reside here; but his opinions took root, and were finally acte on. The shelling the streets was the prominent mean with various details regarding police and individual at tention to cleanliness of yards, &c. Since 1827, th improvements in filling up, building, graduating, an shelling the streets, and paving the side-walks, hav gone on so rapidly as to defy details; but the effect o the comfort and health of the place is abundantly ob vious. In 1822, the first brick tenement was erecte and most of those that were afterwards built prior t 1827, were then burnt down. Now there are betwee 300 and 400. One entire new street in front has bee made, having encroached on the river to the depth o six or eight feet of water: and from thence back to th bluff, the ground is well filled up—every street shelle —all the alleys—many of the yards—all the publi warehouse yards, and the tavern yards, are shelled—several of the streets are shelled for half a mile back and one that meets a leading road is shelled over mile—many of the cross streets are shelled, and er long, every street in the city will be shelled—it is, in deed, the settled policy, and without any *constitutiona bar* to its exercise. Mobile has been uniformly health since 1827—and I have been particular in my detail that you might the better judge whether it resulte from the shelling system. You will, no doubt, giv due weight to the circumstances of all the flat bein well filled, and mostly covered with fine brick build ings. Last fall and this summer, while the choler raged so fatally in New Orleans, Mobile was visite with very few cases, and they excited little or n alarm. In the first instance, nine or ten cases were re ported: the deaths were four or five. In the last in stance, no public reports were deemed necessary, an I cannot say, with any precision, how many cases oc curred. I heard of some few deaths among the black —and the city continues perfectly healthy up to thi time. The shells that are used are cockle, or sea mus cle, as some call them. They are the size of a ha dollar, to that of a dollar, of the form of a clam shel and they are pretty thick and solid. They aboun about the shores of the bay, and are contained i large banks upon the marsh islands opposite and abov the city; perhaps having been the *nuclei* upon whic those islands were formed. The shells are brought i large lighters, as your correspondent 'M.' informs you [Farmers' Register Vol. I. No. 3, p. 152.] When th street is graduated after the manner of turnpiking, th shells are carted and spread over the street to th depth of four or five inches. The spreading hardl forms a moment's obstruction to the passage along th street: as soon as they are spread, which is done b scattering them with a spade, carriages and horses pas over them, and they very soon form a crust, so we cemented as to be difficult to dig up with a pickax They wear out, by very constant use on the most fre quented streets, but, by a little attention to breaks an thin places, when a street is once shelled, it is ver easily kept in repair.

"I have been informed the shelling system has bee attempted in New Orleans; but it will not answer fo that place, owing to the ground being so much saturate with water as not to sustain the shells. I learn that is difficult to make the deepest paving stand well, fro that cause. If it will answer, I doubt not that Ne Orleans would find its account in covering every inc of its whole area. H."—*Farmers Register Vol. I. N 5, p.* 277.

## NOTE O. Page 68.

### DISCOVERY OF MAGNESIAN MARL IN THE GRANITE AND COAL REGION OF VIRGINIA

The magnesian marl of Hanover was discovered by John H. Steger, Esq. in 1833. Very minute accounts of its appearance, and of its chemical composition, were given soon afterwards in the Farmer's Register, Vol. I. pages 424, 425, 462. It had the appearance of a hard chalk, except in color, which was ash color when wet, and a dark or dirty white when dry. No shells, nor any appearance of their having been present, could be seen. but a fossil tooth, of the kind called the shark's, was found, which directed to the discovery, and sufficiently attests the marine formation of the bed. With muriatic acid its effervescence was so uncommonly slow, as to induce, at first, the belief that its calcareous proportion was very small—and upon a more full trial, this circumstance caused me to suspect the presence of carbonate of magnesia, (which had not been met with in any other earth,) and which, in fact, was found, to the amount of thirty-one per cent., besides the very large proportion of fifty per cent. of carbonate of lime. Mr. Rogers afterwards analyzed part of the same specimen, by a different and more accurate process, as well as with far more knowledge of the subject, and obtained very nearly the same proportions of these carbonates. From sixty grains of earth he obtained of

| | | | |
|---|---|---|---|
| Carbonate of lime, | 31 grains | = per cent. | $51\frac{2}{3}$ |
| Carb. of magnesia, | 18 | .... | 30 |
| Silica, | 7 | .... | $16\frac{2}{3}$ |
| Alumina, | 3 | | |
| Loss, | 1 | .... | $1\frac{2}{3}$ |
| | 60 | | 100 |

The locality of this earth was as singular as its composition. According to the account furnished of its discovery, (by Dr. Meaux, in the Farmers' Register, Vol. I. p. 424,) Bear Island, where the bed was found, "lies between the first branches of Pamunky River in Hanover county," and "is situated on the first bed, and within a short distance of the first out cropping of granite, in ascending the Pamunky, and is pretty clearly in the same geological range that the Chesterfield and Henrico coal mines are, being in a northeastwardly course from them, and showing thin strata of coal in a bluff of free-stone which overlooks Little River, a tributary of the Pamunky, and is the northern boundary of the [Bear Island] tract."

No late information has been received, showing whether any use has since been made of this earth as manure, or whether further discoveries of the extent of the bed have been made.

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## A TABLE

### SHOWING THE NUMBER OF SPACES CONTAINED IN AN ACRE OF LAND, AT VARIOUS GIVEN DISTANCES.

The following table will be found useful for fixing the proper distances to place marl, lime, or other manures, so as to give any desired quantities to the acre. The last table though not relating strictly to the subject of manures, is convenient for fixing proper distances for planting, and other operations.

Abridged from the American Farmer of 1820.

| Feet. | | Feet. | | Ft. | | Ft. | | Ft. | | Ft. | | Ft. | | Ft. | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 40 | by | 40 | 27 | 20 | by | 16 | 136 | 18 | by | 13 | 186 | 15 | by | 13 | 223 |
| 39 | " | 39 | 28 | do | " | 15 | 145 | do | " | 12 | 201 | do | " | 12 | 242 |
| 38 | " | 38 | 30 | do | " | 14 | 155 | do | " | 11 | 220 | do | " | 11 | 264 |
| 37 | " | 37 | 31 | do | " | 13 | 167 | do | " | 10 | 242 | do | " | 10 | 290 |
| 36 | " | 36 | 33 | do | " | 12 | 181 | | | | | | | | |
| 35 | " | 35 | 35 | do | " | 11 | 198 | 17 | by | 17 | 150 | 14 | " | 14 | 222 |
| 34 | " | 34 | 37 | do | " | 10 | 217 | do | " | 16 | 160 | do | " | 13 | 239 |
| 33 | " | 33 | 40 | | | | | do | " | 15 | 170 | do | " | 12 | 259 |
| 32 | " | 32 | 42 | 19 | " | 19 | 120 | do | " | 14 | 180 | do | " | 11 | 282 |
| 31 | " | 31 | 45 | do | " | 18 | 127 | do | " | 13 | 197 | do | " | 10 | 311 |
| 30 | " | 30 | 48 | do | " | 17 | 134 | do | " | 12 | 213 | | | | |
| 29 | " | 29 | 51 | do | " | 16 | 143 | do | " | 11 | 232 | 13 | " | 13 | 257 |
| 28 | " | 28 | 55 | do | " | 15 | 152 | do | " | 10 | 256 | do | " | 12 | 279 |
| 27 | " | 27 | 59 | do | " | 14 | 163 | | | | | do | " | 11 | 304 |
| 26 | " | 26 | 64 | do | " | 13 | 176 | 16 | " | 16 | 170 | do | " | 10 | 335 |
| 25 | " | 25 | 69 | do | " | 12 | 191 | do | " | 15 | 181 | | | | |
| 24 | " | 24 | 75 | do | " | 11 | 208 | do | " | 14 | 194 | 12 | " | 12 | 302 |
| 23 | " | 23 | 82 | do | " | 10 | 229 | do | " | 13 | 209 | do | " | 11 | 330 |
| 22 | " | 22 | 90 | | | | | do | " | 12 | 226 | do | " | 10 | 363 |
| 21 | " | 21 | 98 | 18 | " | 18 | 134 | do | " | 11 | 247 | | | | |
| 20 | " | 20 | 108 | do | " | 17 | 142 | do | " | 10 | 272 | 11 | " | 11 | 360 |
| do | " | 19 | 114 | do | " | 16 | 151 | | | | | do | " | 10 | 396 |
| do | " | 18 | 121 | do | " | 15 | 161 | 15 | " | 15 | 193 | | | | |
| do | " | 17 | 128 | do | " | 14 | 172 | do | " | 14 | 207 | 10 | " | 10 | 435 |

*Table of planting distances.*

| Ft. | | Ft. In. | | Ft. In. | | Ft. In. | | Ft. In. | | Ft. In. | | Ft. In. | | Ft. In. | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 9 | by | 9 | 537 | 5 6 | by | 3 9 | 2112 | 4 6 | by | 2 0 | 4840 | 3 3 | by | 3 3 | 4124 |
| do | " | 8 | 605 | do | " | 3 6 | 2262 | do | " | 1 9 | 5531 | do | " | 3 0 | 4818 |
| do | " | 7 | 691 | do | " | 3 3 | 2436 | do | " | 1 6 | 6453 | do | " | 2 9 | 4873 |
| do | " | 6 | 806 | do | " | 3 0 | 2640 | do | " | 1 3 | 7744 | do | " | 2 6 | 5361 |
| do | " | 5 | 968 | do | " | 2 9 | 2880 | do | " | 1 0 | 9680 | do | " | 2 3 | 5956 |
| 8 | " | 8 | 680 | do | " | 2 6 | 3168 | 4 3 | " | 4 3 | 2411 | do | " | 2 0 | 6701 |
| do | " | 7 | 777 | do | " | 2 3 | 3520 | do | " | 4 0 | 2562 | do | " | 1 9 | 7658 |
| do | " | 6 | 905 | do | " | 2 0 | 3960 | do | " | 3 9 | 2733 | do | " | 1 6 | 8935 |
| do | ,, | 5 | 1089 | do | " | 1 9 | 4525 | do | " | 3 6 | 2914 | do | " | 1 3 | 10722 |
| do | " | 4 | 1361 | do | " | 1 6 | 5280 | do | " | 3 3 | 3153 | do | " | 1 0 | 13403 |
| do | " | 3 | 1815 | do | " | 1 3 | 6336 | do | " | 3 0 | 3416 | 3 | " | 3 0 | 4840 |
| 7 | " | 7 0 | 888 | do | " | 1 0 | 7920 | do | " | 2 9 | 3727 | do | " | 2 9 | 5289 |
| do | " | 6 6 | 957 | 5 | " | 5 0 | 1742 | do | " | 2 6 | 4099 | do | " | 2 6 | 5808 |
| do | " | 6 0 | 1037 | do | " | 4 9 | 1834 | do | " | 2 3 | 4555 | do | " | 2 3 | 6453 |
| do | " | 5 6 | 1131 | do | " | 4 6 | 1936 | do | " | 2 0 | 5124 | do | " | 2 0 | 7260 |
| do | " | 5 0 | 1244 | do | " | 4 3 | 2049 | do | " | 1 9 | 5856 | do | " | 1 9 | 8297 |
| do | " | 4 6 | 1382 | do | " | 4 0 | 2178 | do | " | 1 6 | 6832 | do | " | 1 6 | 9680 |
| do | " | 4 0 | 1555 | do | " | 3 9 | 2323 | do | " | 1 3 | 8199 | do | " | 1 3 | 11616 |
| do | " | 3 6 | 1777 | do | " | 3 6 | 2489 | do | " | 1 0 | 10249 | do | " | 1 0 | 14520 |
| do | " | 3 0 | 2074 | do | " | 3 3 | 2680 | 4 | " | 4 0 | 2722 | 2 9 | " | 2 9 | 5760 |
| do | " | 2 6 | 2489 | do | " | 3 0 | 2904 | do | " | 3 9 | 2904 | do | " | 2 6 | 6336 |
| do | " | 2 0 | 3111 | do | " | 2 9 | 3168 | do | " | 3 6 | 3111 | do | " | 2 3 | 7040 |
| do | " | 1 6 | 4148 | do | " | 2 6 | 3484 | do | " | 3 3 | 3350 | do | " | 2 0 | 7920 |
| do | " | 1 0 | 6222 | do | " | 2 3 | 3872 | do | " | 3 0 | 3630 | do | " | 1 9 | 9051 |
| 6 6 | " | 6 6 | 1031 | do | " | 2 0 | 4356 | do | " | 2 9 | 3960 | do | " | 1 6 | 10560 |
| do | " | 6 0 | 1116 | do | " | 1 9 | 4978 | do | " | 2 6 | 4356 | do | " | 1 3 | 12670 |
| do | " | 5 6 | 1218 | do | " | 1 6 | 5808 | do | " | 2 3 | 4840 | do | " | 1 0 | 15840 |
| do | " | 5 0 | 1340 | do | " | 1 3 | 6969 | do | " | 2 0 | 5445 | 2 6 | " | 2 6 | 6969 |
| do | " | 4 6 | 1489 | do | " | 1 0 | 8712 | do | " | 1 9 | 6222 | do | " | 2 3 | 7740 |
| do | " | 4 0 | 1675 | 4 9 | " | 4 9 | 1930 | do | " | 1 6 | 7260 | do | " | 2 0 | 8712 |
| do | " | 3 6 | 1914 | do | " | 4 6 | 2037 | do | " | 1 3 | 8712 | do | " | 1 9 | 9956 |
| do | " | 3 0 | 2233 | do | " | 4 3 | 2157 | do | " | 1 0 | 10890 | do | " | 1 6 | 11616 |
| do | " | 2 6 | 2680 | do | " | 4 0 | 2292 | 3 9 | " | 3 9 | 3097 | do | " | 1 3 | 13939 |
| do | " | 2 0 | 3350 | do | " | 3 9 | 2445 | do | " | 3 6 | 3318 | do | " | 1 0 | 17424 |
| do | " | 1 6 | 4467 | do | " | 3 6 | 2620 | do | " | 3 3 | 3574 | 2 3 | " | 2 3 | 8604 |
| do | " | 1 0 | 6701 | do | " | 3 3 | 2821 | do | " | 3 0 | 3872 | do | " | 2 0 | 9680 |
| 6 | " | 6 0 | 1210 | do | " | 3 0 | 3056 | do | " | 2 9 | 4224 | do | " | 1 9 | 11062 |
| do | " | 5 9 | 1262 | do | " | 2 9 | 3334 | do | " | 2 6 | 4646 | do | " | 1 6 | 12906 |
| do | " | 5 6 | 1320 | do | " | 2 6 | 3668 | do | " | 2 3 | 5162 | do | " | 1 3 | 15488 |
| do | " | 5 0 | 1452 | do | " | 2 3 | 4075 | do | " | 2 0 | 5808 | do | " | 1 0 | 19360 |
| do | " | 4 6 | 1613 | do | " | 2 0 | 4585 | do | " | 1 9 | 6637 | 2 | " | 2 0 | 10890 |
| do | " | 4 0 | 1815 | do | " | 1 9 | 5248 | do | " | 1 6 | 7744 | do | " | 1 9 | 12445 |
| do | " | 3 6 | 2074 | do | " | 1 6 | 6113 | do | " | 1 3 | 9272 | do | " | 1 6 | 14520 |
| do | " | 3 0 | 2420 | do | " | 1 3 | 7336 | do | " | 1 0 | 11616 | do | " | 1 3 | 17424 |
| do | " | 2 6 | 2904 | do | " | 1 0 | 9170 | 3 6 | " | 3 6 | 3555 | do | " | 1 0 | 21780 |
| do | " | 2 0 | 3630 | 4 6 | " | 4 6 | 2151 | do | " | 3 3 | 3829 | 1 9 | " | 1 9 | 14223 |
| do | " | 1 6 | 4840 | do | " | 4 3 | 2277 | do | " | 3 0 | 4148 | do | " | 1 6 | 16594 |
| do | " | 1 0 | 7260 | do | " | 4 0 | 2420 | do | " | 2 9 | 4525 | do | " | 1 3 | 19913 |
| 5 6 | " | 5 6 | 1417 | do | " | 3 9 | 2581 | do | " | 2 6 | 4978 | do | " | 1 0 | 24454 |
| do | " | 5 3 | 1508 | do | " | 3 6 | 2765 | do | " | 2 3 | 5531 | 1 6 | " | 1 6 | 19360 |
| do | " | 5 0 | 1584 | do | " | 3 3 | 2978 | do | " | 2 0 | 6222 | do | " | 1 3 | 23232 |
| do | " | 4 9 | 1667 | do | " | 3 0 | 3226 | do | " | 1 9 | 7111 | do | " | 1 0 | 29040 |
| do | " | 4 6 | 1760 | do | " | 2 9 | 3520 | do | " | 1 6 | 8297 | 1 3 | " | 1 3 | 27878 |
| do | " | 4 3 | 1863 | do | " | 2 6 | 3872 | do | " | 1 3 | 9956 | do | " | 1 0 | 34848 |
| do | " | 4 0 | 1980 | do | " | 2 3 | 4302 | do | " | 1 0 | 12445 | 1 | " | 1 0 | 43560 |

ERRATA.—The reader is requested to correct the following *errata:* Page 19, col. 1, 14th line—for "*forty-seven*" read "*fifty-seven.*" Page 81, col. 2, 1st line of the note—for "*translation,*" read "*transition.*"

[NOTE S. Page 68.]

ISCOVERIES OF, AND OBSERVATIONS ON THE "GYPSEOUS EARTH," OR GREEN SAND FORMATION, OF VIRGINIA.

After the preceding sheet, which was intended close this work, was in the press, and part of e impression finished, the continuation of Mr. ogers' observations on the green sand of Virgi-a, was received for the Farmers' Register. It ould be improper to omit this piece; and yet to sert it alone would not do justice to the views of author, nor to the statements presented in the ticle on gypseous earth, to both of which the st communication makes frequent reference. n this account (though contrary to the previous tentions expressed in note H.) the first two eces will be here republished, in the order they ppeared, as a necessary introduction to the piece st received, and which will appear in the Farm-s' Register, as well as here, to preserve the pro-er order and connexion of the subject entire in oth publications.

From the Farmers' Register of Sept. 1833.

*The gypseous earth of James River.*

As far back as I can remember, crystals were ometimes found on the river shore at Evergreen, two miles below City Point,) which attracted no rther notice than being admired for their perfect ansparency. At that time it is probable that no ne in the county had ever noticed crystalized ypsum, or even the lump gypsum of commerce, nd no one had given the slightest attention to mi-eralogy. It is therefore not strange that the na-re of these crystals was not suspected before 817, when some person better acquainted with e subject, supposed them to be pure gypsum. he expression of this opinion attracted some no-ce at that time, but was received with general credulity, founded upon the supposed impossibil-y of gypsum existing in this region, where it had ever been heard of before. A lump was sub-itted to the inspection of a French apothecary in etersburg, who had "chemist" painted on his gn: he at once pronounced that the substance as not gypsum, but *isinglass*.

The interest which I had felt with regard to his substance was soon after much increased by nding some small specimens on my own land, Coggin's Point.) Having no prospect of having he question decided by any person possessing a cientific acquaintance with the subject, I consulted ooks, and found such instruction as enabled me to nalyze the substance, and ascertain that it was ure sulphate of lime, or gypsum. But however atisfactory to myself, it must be confessed that my hemical proof was not much valued by others; ecause it was thought impossible that a process elieved to be so mysterious, could be accurately erformed by one who confessedly was ignorant of hemistry, and who had only resorted to its aid for his particular object. To settle all these doubts, I sent collections of choice specimens to two of he most distinguished chemists in the United States, with the request that they would give their testimony as to the nature of the substance. To have complied fully with my wish would not have required fifteen minutes of the valuable time of either of those gentlemen: yet neither paid the slightest attention to the subject nor even returned my specimens. These were certainly the strongest among the very many proofs I have known of how little aid chemists are disposed to offer to agriculture. As these applications had been made to remove the doubts of others, and not mine, and to attract the public attention to what I considered an interesting and perhaps important subject, the results did not discourage the progress of my own investigations.

I had previously ascertained that the gypseous formation was of much greater extent and importance, than the crystals alone would indicate. In all the different places where the crystals had been found, they were imbedded in the same kind of earth, having a very peculiar appearance, and which extended along the south river bank, with but few interruptions, from Bayley's creek to Coggin's Point, a distance of eight or ten miles.—Having so marked a guide for examination as this earth presented, I found gypsum in it in various places, but in such small quantities, that alone it would never have attracted observation. It was evident that gypsum either was, or had been at some former time diffused through the whole body of this earth, and therefore I distinguish it by the general name of *gypseous earth*, although in most cases there may be no gypsum now remaining. This term of course is not always indicative of the present construction of the mass. The gypseous earth is of a dull greenish color, mottled with streaks of bright yellow clay. Where gypsum is visible, it is generally in numerous small crystals; sometimes in coarse white powder. At one spot only (where first discovered) are the crystals large. Here they are sometimes several pounds in weight, and of various and beautiful forms. Some are as transparent as glass' but generally, they are of a dark gray color, owing to a small quantity of dark earthy particles being enclosed between the *laminæ* of the crystals. Except at this place, the solid crystals seldom exceed ten or twelve grains in weight, and generally are less than one grain. The most usual appearance in which they are presented in the bank, is that of a star, formed by numerous rays (each a solid crystal) shooting out from a common centre. As these rays are very slightly attached to each other, they generally fall asunder when removed.

In much the greater part of the gypseous earth which has been yet examined, no gypsum is visible; nor is it believed that even the smallest particle remains. But whether gypsum is present or not, the earth is filled with numerous hollow forms or impressions of shells, so as to prove that this was once part of a bank of fossil shells, (or marl as it is here called) of which the upper part, unchanged, still forms the cover of the gypseous earth, through its whole extent. The yellow clay, before spoken of, is very often presented in the form of shells, as if, when fluid, it had filled their vacant places. Masses of hard marl, coated over with crystalized gypsum, are also found here and there in gypseous earth. A close examination of the bed, and comparing the impressions of shells with the appearance of those still existing in the upper stratum, or in the neighborhood, will leave no doubt on the mind of the observer, of the change having taken place from a bed of fossil shells to gypseous earth.

This conclusion is attended with two difficul-

ties: In the first place, we are at a loss to know by what agency or means could so extensive, regular, and complete a chemical change have been made, as converting all the shelly matter (carbonate of lime) to gypsum, (sulphate of lime.) Secondly, admitting the means to exist, and the change to have taken place, it is still more difficult to guess what has become of the gypsum so formed—as not one-tenth of its proper quantity remains. When sulphuric acid takes the place of carbonic acid in combination with lime, the greater weight of the former, (together with the water chemically combined,) serves to increase the weight of the new compound about fifty per cent: or, in other words, one hundred grains of shells, or pure calcareous earth, if allowed to combine with sulphuric acid, will form at least one hundred and fifty grains of gypsum. So the mere change of acids being made, ought to give us an earth much richer in gypsum than it before was in calcareous matter. Instead of this, the gypsum is no where so plenty as we may suppose the shells formerly were; and by far the greater part of this bed now is entirely destitute of both gypsum and calcareous earth. What has become of it is beyond my power to explain.

The access of waters containing sulphuric acid, or sulphate of iron, would suffice to produce the change of carbonate to sulphate of lime—and the exposure to sufficient water, and for sufficient time, might dissolve and carry off the greater part of the gypsum. Sulphate of iron is perceptible on the surface of some of this earth near the head of tide water on Powell's creek, and was abundant enough to greatly injure the land on which some of that earth was applied thickly, for manure. *Sulphuret of iron* has also been found intermixed with the gypseous earth: and this mineral in contact with carbonate of lime, would also by chemical decomposition and new combination, form gypsum. It was at Berkley, in Charles City, that sulphuret of iron was found by Mr. Benjamin Harrison, near the bottom of a pit of thirty six feet depth, which he caused to be sunk in the beach and through gypseous earth. Many isolated masses of marl were reached, (such as I described above,) and Mr. H. thinks that the gypseous earth also was still calcareous. In either case, the chemical change from the carbonate to the sulphate of lime must be still going on, as the agent, sulphuret of iron, still remained in considerable quantity.

The discovery of the existence of gypsum caused the hope to be entertained at first that it would be found in large bodies, and pure enough to form a valuble commodity for sale, and distant transportation. But the examination which led to the foregoing conclusions, also served to dissipate these expectations. As the shelly bed which was the origin of the gypseous earth, was composed principally of worthless sand and clay, the new gypseous formation must have the same degree of adulteration, which would forbid its sale for transportation.

The only remaining use for the application of the new discovery, was as manure in the neighborhood where it was found: and circumstances then existing, and opinions almost universally entertained, prevented much profit being expected from this source, and discouraged even the experiments necessary to test fully the value of the earth as manure. These circumstances and opinions will be stated.

When the wonderful effects of gypsum as manure in Pennsylvania, and in parts of the mountainous region of Virginia, were first made known the reports excited as much of incredulity as astonishment, or of hope to reap the same reward But as a few pounds of pulverized gypsum wer sufficient for the purpose, almost every farmer i lower Virginia, who was either enterprising or inquisitive, made some small applications for experiment. This was thirty five or forty years ag and perhaps there was not one of these experiment recorded, or the precise result kept in remembrance. But as to the *general* result, there coul be no mistake. The failure was so general, tha every one of the experimenters agreed that gypsu was worthless in lower Virginia; and in that opinion all others concurred. Some marked instance of success presented on Berkley in Charles Cit Curle's, Brandon, and some other fine soils o James River, when the use of gypsum was resumed fifteen or twenty years after, did not shake th opinion of the general unfitness of our land for tha manure. In this opinion I fully concurred—and course could not expect to find our own impur gypseous earth more efficacious, than the pure substance from France or Nova Scotia.

But without expecting profit from the manur the desire to prove its identity with gypsum caused me to make many small experiments with th pounded crystals, and with the earth in which the were found, in 1817, and afterwards. The resul were not such as to promise profit from the extended use, but served to remove all remainin doubt as to the nature of the substance. On th several kinds of clover it sometimes produced remarkable benefit—but more generally, very littl On corn, it was totally inert, except in a very fe cases, and in one of these exceptions, the bene was remarkable. On other grain crops, no effe was ever found. These very different effects, instead of being imputed to the nature of the soi and the crop, (as I have since ascertained to be th true causes,) were supposed to be evidences of th capricious manner in which this manure acte and of its general worthlessness for this region. saw indeed that its best effect was on calcareo soil—and even then began to entertain the opinio which since has been established by facts, that th want of calcareous ingredients in our soils, cause their unfitness to be improved by gypsum. I fe the less inducement however to continue my applications, because my own gypseous earth w poor, and limited in quantity: and I wished to r serve what there was of it for future use, when m land should be made calcareous, and more fit f clover. For these reasons, my use of the gypseo earth was almost abandoned for six or seven year and no other person had then made any experiments to test its value as manure.

In the winter of 1825-6, I found on my land, small body of gypseous earth containing at least on tenth of pure gypsum on the average—and po tions of it had as much as one-fourth. This caused me to resume its use. In 1826, 565 heap bushels were applied, about 20 to the acre, (su posed to give from 2 to 3 of pure gypsum,) to v rious soils, and to different crops. In 1827, b tween 7 and 800 bushels were applied. The eff on clover, on land calcareous by nature, or ma

so by art, was as great generally, as gypsum has ever produced elsewhere. On cotton, and on corn, the effects were irregular, and taken altogether, were not equal to the cost of the application. But though the use of this earth was now confirmed to land made calcareous, (as it was evidently worthless elsewhere,) I again lost the greater part of its value by another improper mode of application, which it may be useful to others to state more fully.

Judge Peters, to whom we are indebted for making known and establishing the value of gypsum, was of opinion that one of its operations is to hasten the rotting of vegetable matter when both are in contact: and thence he deduced the opinion of the propriety of mixing gypsum in heaps of compost, or of other coarse putrescent manure. Besides gaining this particular benefit from mixing the gypseous earth with my stable and farm yard manures, (which I was ready to believe on the high authority of Judge Peters,) I expected to derive from the practice a still greater benefit, in distributing easily and equally the earth over the land, which was very troublesome to spread alone. For these reasons, the greater part of my gypseous earth was spread over the litter in the farm yard and stable, in such quantities as was supposed would give about 20 bushels of the earth to every acre covered by the manure. The heaping of the manure to ferment, then cutting it down to load, and spreading it over the field, no doubt divided and distributed the gypseous earth very equally. It showed no effect on the succeeding crop, corn, (at least none that could be distinguished from that of the putrescent manure,) and none on the wheat, which followed. I had not expected much better results on these crops, but relied confidently that my clover, sown on the wheat, would show the effect of the gypseous earth equal to any on other land, where it had been applied alone. In this I was totally disappointed. Not the least effect of gypsum could be discovered on the clover—and thus the whole of this application was thrown away, as well as the greater part of the succeeding winter's application, which in like manner had been mixed with my other manure, and which had not then arrived at the time to prove its uselessness. The cause of this inefficiency is now plain enough. Fermenting manure, (and probably all fermenting vegetable matter,) forms *oxalic acid*, which attracts lime so powerfully as to take it from all other combinations in which it can be presented. This acid thus meeting with the sulphate of lime in the gypseous earth, at once decomposed it, and destroyed the peculiar manure before existing. No particle of gypsum remained to be carried out, and act on the land. It is useless here to extend my remarks on the operation of oxalic acid, as it has been done at length elsewhere:* it is sufficient to show by this statement that my obstinate adherence to this mode of application, for two winters, caused the loss of the greater part of gypseous earth, as well as the labor of applying it. The rich seam was by that time exhausted, and my later use has been with the poorer body, which, it is possible, may not be cheaper than to buy the imported gypsum. However, within the last year, my friend and neighbor Thomas Cocke of Tarbay, by applying earth apparently still poorer in gypsum, has produced such remarkable benefit on clover, that I am encouraged to return again to this kind of manure. The earth he uses is brown, and differs much from the general appearance as described above. We are both satisfied that the gypseous earth possesses some power to aid the growth of clover, independent of the pure gypsum contained. Last year, (1832) to test this opinion, I sowed French gypsum on clover at the different rates of 1, 2, 3 and 4 bushels to the acre on marked spaces. The benefit of the smallest application doubled the crop of clover—and it was increased by the heavier dressings, though not at all proportioned to the quantities applied. But the clover on the heaviest application (of 4 bushels,) was not to compare to the effect seen on neighboring and similar land, from 20 bushels of my best gypseous earth, and which was not greater than had often been found elsewhere. Mr. Cocke finds equal benefit, on clover made on poor light land, (that is, it is made as heavy as it can well stand,) from 40 bushels of his earth which appears so poor. It is necessary to observe that all these instances of benefit are on land made calcareous by fossil shells: and on my own, last spoken of, before that operation, the gypseous earth had been used, in heavy as well as light applications, and without the least effect. The very rich bed of gypseous earth at Evergreen has only just now been opened for use.

The statements made of my own practice show that I cannot boast of having derived much (if any) profit from the use of gypseous earth. Nevertheless, my experience may be more useful to others than it has been to myself, and the misapplications caused by my inexperience and ignorance may serve to show others, who have access to such manure, how to make proper use of it. Within the last year, circumstances have attracted attention, and been made public, which induce the belief that this formation of gypseous earth is much more extensive than was before supposed. The marl beds in Hanover and Henrico, not far below the granite ridge, are covered by an upper bed of clay, which is very different in appearance from our gypseous earth, but agrees with it in being full of impressions of shells, and being destitute of any portion of the carbonate of lime, with which it was evidently so well furnished at some former time. No gypsum is visible. This earth also differs from that of Prince George in containing pure sulphur generally diffused throughout, as made evident by its strong sulphureous scent. I do not know that this singular and extensive formation is valuable as manure—but it is at least worth examination and trial. The clay bank through which Governor's street in Richmond is cut, is full of such impressions of shells, though it does not contain, and is not known even to cover, any remaining calcareous matter. If shells are below, as is probable, this is very near their termination in that direction.

In the bed of Howard's Creek, at the point where it flows nearest to to the White Sulphur Spring, (within a few hundred yards distance,) there are many pebbles, varying greatly in form, appearance, and chemical composition, but agreeing in containing (like the earth before described) numerous hollow forms of small shells, of which nothing of the substance now remains, nor any

* Essay on Cal. Man. pp. 143, 224. [2d Ed. p. 92.]

trace of carbonate of lime. These stones are as solid and hard as those of similar external appearance usually are, which makes still more strange and unaccountable the entire disappearance of the shells which have at a former time been enclosed. I have mentioned this fact because it may possibly attract the attention of some of the men of science who visit that place, and induce them to observe and explain these singular facts. The silicious fixed rocks lying close by the Sulphur Spring also have many star-like impressions on their surfaces, (but not within, as in the other cases,) which from their similarity and regularity of form, must have been caused by small shells of one particular species. I found a similar impression on a pebble in the bed of the Calf Pasture River—and perhaps such facts may be numerous, and well known to others. In all these cases, there was not the least particle of carbonate of lime remaining in these stones, (as proved by chemical tests,) nor any appearance (to the eye) of any other salt of lime, to which the carbonate might have been changed.

The highland which lies over the whole extent of the gypseous formation in Prince George presents a surface and qualities of very peculiar appearance, and which may possibly have some connection with the gypseous bed below. If so, my description may direct more successfully the search for gypseous earth elsewhere. The land from Bayley's Creek to Coggins' Point, except where interrupted by some low alluvial tracts, seems as if it had been originally a high and level bluff, or abrupt termination of table land, which had sunk in successive slices, the lowest next the river, so as now to present somewhat the appearance of a hill side cut into terraces. Of course, this form is extremely irregular. The broken strata cause the greatest variety of surface: fossil shells fit for use as manure, barren clay, barren calcareous sand, and rich black soil, were all to be found in almost every acre, and remained distinct, until mixed by the cultivation of the surface. It does not rest on mere conjecture that this land took its present form and depression by sinking or *slipping*, as a similar natural operation to considerable extent, has taken place on the Tarbay farm within a few years, the progress and consequence of which are still visible.

The rich gypseous bank, at Evergreen, is at a place where the river is encroaching on the land, and every storm, or very high tide, adds to the acres which have doubtless been already swept away. In this manner was formerly exposed the remains of the trunk of a tree, lying even with the beach, and which when wet, presented the same spongy and soft texture on the surface, smooth and even yielding to the touch, as is usually seen in rotten and water-soaked logs. But except the surface, where water had probably dissolved the substance, every pore and cell of the log was filled with gypsum, though the form and grain of wood remained distinct. This complete filling of the cells could only have taken place when the gypsum was in a fluid state. The circumstance of a tree being found beneath a bank of shells, or what had been shells, might seem to be a proof that the shells were the later deposite of the two. But it is easier to believe that the whole body of earth, (though perhaps 50 feet high) was formerly thrown into its present place, by one of those land-slips which have been already spoken of.

There is a kind of earth in New Jersey which was called *marl*, (as almost every earthy manure has been) but which seemed to me, from the imperfect descriptions given of it, to be the same kind of gypseous earth that I have described. Although this Jersey manure excited attention, and was bought, and tried, and reported on, by Judge Peters, there was no certain indication given to the public of the component parts of the earth, or what constituted its fertilizing power. Judge Peters speaks thus of it. "It is said by some that the *Jersey pyritous earth, called marl*, is of this description, [i. e. a mere stimulant;] and by others that it is permanently fertilizing. Nothing decisive can yet be pronounced, as its many varieties differ in their respective effects. There are facts both ways; so that this earth when applied, and the soil it is intended to assist, should be carefully scrutinized, and the qualities practically known. Some English chemists to whom it has been sent, style it an *hydrat of iron;* while others designate its composition, as a collection of decomposed *granite, schorl, silex, alumine, iron;* in some specimens (no doubt those mixed with shells,) *lime* and *magnesia*, with *sulphur*. A more accurate knowledge of its parts and properties, is still required; and it is to be wished that our own chemists will give us their assistance. *Broom grass* and other pests on worn lands, may be destroyed by a top dressing of this earth and chloritic sands of a similar, though not so potent a nature; which substitute a natural growth of white clover."* In a communication of later date, Judge Peters made the following incidental remarks. "Four years ago, I procured 40 tons of Jersey manure, and spread it as a top dressing on many parts of the Belmont farm, on sand, clay, loam, and in every variety of exposure, as well as on moist and dry grounds. But in no instance any profitable effect appeared. A broad strip of the lawn, light and sandy, had been top dressed, and showed no signs of melioration heretofore. This strip is part of my little oat field; and it has [this year] thrown up a most luxuriant growth, far exceeding any other part, (though the whole was good, having been well *limed* throughout,) and affords a proof that this manure agrees with and co-operates with lime. I never saw, in the richest soil, stronger, better headed, or more promising plants. It would have been incompatible with my objects, or I should have suffered it to ripen, for experiment of its product. Mr. Mark Reeve, who is very intelligent on this subject, (and to whom I sent a sample of the manure,) informed me that I had been imposed on by the person from whom I procured it; the article used by me being only the cover of the true kind. Its effect, luxuriant as it is, must have been more so, if the perfect manure had been used."† I have seen it stated elsewhere, (though I am not able now to refer to the authority) that the Jersey earth was particularly beneficial to clover, and that it was used in small quantities, compared with other manures.

This description of the Jersey earth, and the

* Notices for a Young Farmer—by Judge Peters.—Phil. Memoirs, vol. 4.

† Phil. Memoirs, vol. 4.

effects imputed to its use, agree very closely with those of our gypseous earth. But it also seems, that no one entertained a suspicion that its value was owing to its containing, or forming gypsum. I therefore infer that the earth there used was similar to the great body and poorest kind of ours, having not a particle of gypsum remaining. If so, the effects produced as manure, were probably owing to either *sulphate of iron*, or *sulphuret of iron* remaining in excess in the earth—which, when meeting with *lime* in the soil, formed gypsum—and if no lime was present, remained either (as the *sulphuret*,) an inert, or (as the *sulphate of iron*,) a poisonous ingredient of the soil. *Iron pyrites* (sulphuret of iron) have been used with much benefit as manure—though that effect would probably depend on whether the soil was calcareous or otherwise.

From the publication of the passages quoted above, and many others on the same manure that appeared about 1819, and soon after, it might be supposed that the attention and labors of chemists would have been drawn to this manure, and its composition and value clearly settled; and that practical farmers would have fully profited by this instruction. On the contrary, all notice of the manure soon ceased, and no information thereon has since been given to the public. It may therefore be inferred that the manure was used so ignorantly, as not to be found profitable in general, and that even the solicitations of Judge Peters, and the influence of his venerable name, could not obtain this small aid from men of science, which might have shown when and why the manure was useful, or otherwise. If my views of its constitution are not mistaken, it is certain that this manure will be found useless on most poor soils, unless calcareous earth is used previously, or in conjunction.

EDMUND RUFFIN.

*Shellbanks, Aug.* 9, 1833.

*On the discovery of green sand in the calcareous deposite of Eastern Virginia, and on the probable existence of this substance in extensive beds near the western limits of our ordinary marl.*

*William and Mary College, June* 26, 1834.

To the Editor of the Farmers' Register.

Since my attention was drawn to the nature and properties of the New Jersey green sand, by the specimens which you sent me for analysis, and by our more recent conversations on the subject, I have made a visit to the region in which it is found, and have witnessed the most striking evidences of its utility as a manure. During this excursion, I examined the marl in all its varieties, and learned many interesting particulars respecting its use, from intelligent farmers, long experienced in applying it to the soil. I have moreover analyzed several specimens collected on the spot with the view, if possible, of throwing some light upon its agency when applied to the soil.

Since my return, I have made diligent search for this substance in our marl beds and the accompanying strata, and am at present directing my inquiries to that region of Lower Virginia in which, according to geological laws, as well as from some indications of which I have heard, this deposite may reasonably be expected to occur. As far as relates to the marl beds of this vicinity, my search has been unexpectedly successful. With scarce a single exception, I have discovered particles of the green sand, mingled with the ordinary sand, clay, and shells; and in some instances, in so large a proportion as no doubt greatly to enhance the useful agency of the calcareous matter. Indeed, I am inclined to believe, that in some cases, the agricultural efficacy of the marl is chiefly owing to the green sand which it contains. In this conclusion I think I shall be sustained by facts hereafter to be noticed.

The general occurrence of this substance in our marl beds, is certainly a discovery of some interest; and though I may perhaps exaggerate its importance in a practical point of view, I cannot but think that it is worthy of the attention of our farmers. I speak of its *general* occurrence, because, although I have examined but few specimens from a distance, the general resemblance of our marl deposite throughout, together with the almost invariable presence of the green particles in such as I have inspected, would seem to justify the conclusion that it is a usual accompaniment of our marl formation, though by no means in equal proportions in all localities. Out of more than forty specimens which I have examined, there were only two in which the green particles could not be discovered; and as they frequently occur in patches, and not generally diffused throughout the bed, it is probable that even in the beds from which these two specimens were procured, the green sand might be elsewhere found. Some of the most efficient marls in the neighborhood of Williamsburg, contain a marked proportion of this substance. At Burwell's Mill, (three miles below the city towards Yorktown) the intermixture is so large, that the sand and *detritus* of shells washed down by the spring freshet display a very distinct greenish olive tinge, which even travellers observe as they pass through the valley in which the deposite exists. At this place, the shells, as they are taken out of the extensive bank recently exposed by the torrent, are frequently filled with a dark mass containing as much as thirty per cent. of the green particles. In fact the whole bank is strongly tinged by them and the stratum which overlies the shells, in some places five feet in thickness, is precisely similar to some of the poorer deposites in New Jersey, and contains upwards of thirty per cent. of this substance. In Judge Semple's marl beds, in the same vicinity, the green particles are equally abundant—and, as in the former case, extend into the incumbent stratum of non-calcareous matter. In many instances, this layer of overlying earth has been found even more efficacious on the soil than the subjacent marl—a fact which might naturally be inferred, when the green particles abound chiefly in the upper stratum, from the extraordinary efficiency of the green sand as experienced in New Jersey. But by far the most interesting locality of this substance in point of extent, which I have examined, occurs on the shore of James River, adjacent to King's Mill and Littletown. Here the banks rise perpendicularly to the height of from forty to sixty feet, and for about three-fourths of this elevation are composed of shells and earth mingled with a large proportion of the green sand which in some places imparts a distinct color to the surface. The sand

of the beach is also filled with these particles which the rains have washed down, and which, at first view, present the appearance of the common black sand of our river, though in much larger quantity. At Bellefield, and other places on the York river, the banks and beach are similarly impregnated.

The green particles may be readily recognised by their want of lustre, the ease with which they may be bruised with the point of a penknife, and the bright green stain which they then produce. In examining earth or marl in which they are very sparsely scattered, the particles are sometimes difficult to separate from the other matter. My method is to moisten the end of the knife blade by applying it to the tongue, and then to remove several of the particles by adhesion. When placed upon a card and bruised, they leave a brilliant stain. This test may be confidently relied on.

The occurrence of the green sand so extensively through our marl region, affords strong grounds for hoping that valuable beds of this substance, like those of New Jersey, almost entirely unmingled with other matters, may be brought to light by a judicious and enterprising examination of the district on the western limits of our marl. And should such a discovery be made, the agriculture of Lower Virginia would become possessed of a new and powerful auxiliary in furthering its already rapid career of amelioration. Even the fact that the green sand often exists in considerable quantities in and above our ordinary marl beds, which is I think now sufficiently established, may furnish no unimportant aid in the improvement of our lands, by leading to a more varied and judicious adaptation in the application of our manures.

Independently of the existence of the green sand in a scattered state in our calcareous strata, there are other and stronger reasons for believing that a deposite similar to that in New Jersey will be found in the appropriate region. In a geological arrangement of our various formations, the marl beds of Eastern Virginia and Carolina, as well as those of Maryland, belong to a later period in the physical history of our country, than the green sand formation of New Jersey—the former being referred to the tertiary—and the latter to the secondary epoch of geologists. Now this tertiary deposite extends into New Jersey, and is found in many places in the latter state nearly contiguous to the green sand. Moreover, indications of the New Jersey formation have been found in Maryland—and such is the general regularity with which the different geological deposites are arranged, that we may fairly infer the existence in Eastern Virginia of the green sand, or some deposite equivalent in a geological point of view—though at the same time it by no means follows that the green sand, if actually found, would be sufficiently near the surface to render it extensively available as a manure. The object however is of such magnitude, as to justify a very diligent examination, and I am therefore desirous of enlisting in this research all those readers of the Register who reside in the region which has been alluded to before. As however the success of this investigation will be greatly promoted by an acquaintance with the indications by which the green sand, or its geological equivalents are to be recognised, and some knowledge of the properties and constitution of the substance itself, I shall here give a brief account of the New Jersey formation which I visited, together with the result of several chemical analyses of the sand carefully executed by myself and others: and further to interest your readers in this important inquiry I shall add a statement of such facts bearing upon the application and agency of the marl, as I was enabled to collect during my visit to the beautiful region which it has so largely contributed to fertilize and adorn.

The New Jersey green sand is apparently identical with that series of deposites recognised in Europe by the name of the green sand formation, characterised by a predominance of minute green particles in many of its strata. In Europe these strata are generally found alternating with beds of chalk; but in this country no chalk is found, unless in the region west of the Mississippi. The fossils embedded in the green sand on both sides of the Atlantic, are however so strictly alike, that the geological equivalence of the American and European beds can scarcely admit of question. and is therefore generally conceded as an established point. It is relevant here to remark that in tracing cotemporaneous or equivalent geological formations in different regions, geologists are accustomed to rely almost exclusively upon the fossils, whether shells, bones, or vegetable remains, which the strata may contain—a procedure to which they have been led by the whole tenor of modern developements in geology. Now with reference to the New Jersey formation, though it would be impossible without numerous drawings, and much descriptive matter, uninteresting to general readers, to convey a knowledge of even the principal shells and other fossils existing in the green sand, some account of a few of these fossils may possibly be useful in the inquiries which I trust many of your readers will be prompted to undertake.

1st. *Lignite*, or carbonized wood, often associated with iron pyrites of a bright yellow lustre, frequently occurs in the beds overlying the green sand formation, though it sometimes occurs in other situations.

2nd. *Amber* is often found in a similar position, as was the case at the Delaware and Chesapeake Canal.

3rd. *Belemnites*—a fossil of a yellow or brown color, in shape somewhat like a cigar, but rather thicker—very brittle, and usually found broken transversely so as to exhibit its tubular character within.

4th. *Ammonites*—a fossil presenting the appearance of a snake coiled up in a flat coil, and frequently large and ponderous.

5th. The *Echinus*, or Sea Urchin—sometimes globular, at other times much flattened, having numerous little warty prominences, and minute perforations symmetrically arranged on its surface, and when entire, occasionally furnished with spines or prickles.

6th. *Gryphæa*—a shell having one valve very deep and convex, and the other flat. It somewhat resembles the small shell (chama) very abundantly found in our marl beds. This latter is smaller—has a rougher exterior, and has two muscular impressions in each valve—whereas the Gryphæa has but one.

7th. *Exogyra*—a shell like the former, with one

convex and one flat valve—but a great deal rougher and more irregular in aspect, and of large dimensions.

8th. The *Falcated Oyster*—a beautiful shell about one and a half or two inches in length, and bent like a Turkish scimetar.

These rude descriptions, which have no pretensions to scientific accuracy, are designed to draw attention to such fossils as may be brought to light in the region in which the green sand may be expected to occur—and in this point of view may prove of real value in examining for that deposite. Of course a scientific inspection of the fossils would be necessary to establish their identity, but this can readily be procured by transmitting them to the Academy of Sciences in Philadelphia, or by sending them to William and Mary, where they would be carefully examined and compared with the New Jersey fossils as collected and described. Indeed there is reason to believe that some of the characteristic fossils have already been found in Eastern Virginia. A bed of Lignite has been lately discovered on the Rappahannock, a few miles below Fredericksburg, the very point at which it might be expected to appear, and from information recently received, I am disposed to believe that Belemnites may be found near the mouth of Potomac Creek. It has been said also that the Gryphæa has been found, but I have not heard in what vicinity. These facts should furnish an additional stimulus to inquiry, and literally no stone should be left unturned in pursuit of so important a discovery.

The New Jersey green sand is generally found in the valley and meadows, though occasionally it rises to some height in the surrounding hills. Its depth in many places is very great, and several strata occur, separated by layers of shells, or blue clay, or sand colored by iron. The general aspect of the green sand is that of a bank of moist bluish clay—though in some places the green tint is very perceptible. This however only occurs where the earth is dry. When thrown into heaps by the side of the pit, the mass falls into a coarse powder, in texture and color very closely resembling gunpowder, on which account it is very commonly known by the name of *gunpowder marl*. This mass consists in very large proportion of the pure green sand, having a slight admixture of clay, and in many places of minute fragments of shells. Occasionally, the bank presents a mass of the pure green sand itself—and again, in some places the shells predominate. In one of the beds in the vicinity of New Egypt, I discovered small spiculæ of gypsum, or sulphate of lime: but this occurred at no other locality—and in this place the crystals were so minute and few in number as to require the use of a microscope to be seen distinctly. The moist marl when warmed in the hand exhales a strong phosphoric odor, a fact which I believe has not been hitherto remarked.

As already observed, the marl frequently contains shells both in an entire and broken condition. This however is by no means universal. In fact, the great majority of those beds in actual use contain either no calcareous matter, or a very minute proportion of it. This I ascertained by chemical examination. In the vicinity of Arney's Town, Crosswick's Creek, and Shrewsbury, as well as other places, much of the marl which the farmers spread over their land, contains no carbonate of lime; while at New Egypt the calcareous and non-calcareous marls are both extensively employed. The same is true likewise, of the beds farther south at Mullica Hill. The green particles themselves have an invariable composition—and those of our Virginia marl beds are perfectly identical with those of the New Jersey deposite. Thirty grains of the green sand yielded by careful analysis—

| | |
|---|---|
| Silica, | 15.51 grs. |
| Protoxide of iron, | 7.56 " |
| Potash, | 3.10 " |
| Water, | 3.00 " |
| Magnesia, a trace. | |

These results agree very closely with the determination of Berthier of France, and Seybert of Philadelphia. The former operated upon the green sand of Europe, the latter upon that of New Jersey. It appears therefore that the predominant constituents are silica and oxide of iron. The potash, amounting to about ten per cent. is most probably the ingredient chiefly concerned in the agricultural agency of the marl, though in what way its connexion with the other ingredients is severed when the marl is spread upon the land, I am at a loss to conjecture.

Throughout all the district in which this deposite occurs, it is extensively employed in agriculture. In the neighborhood of Arney's Town, one of the points which I visited, it has been used as a manure for the last thirty years—but its general introduction is of more recent date. In the region in which the marl chiefly abounds, the soil is loamy, having in some places a large intermixture of tenacious clay. East of this tract, which is a narrow band nearly parallel to the Delaware River, the country assumes an appearance very similar to that of the sandy lands of Eastern Virginia, covered with a thick growth of pine, and comparatively unproductive. On both these varieties of soil the green sand is continually used with the most striking benefit. For the clay soils, the more sandy marls are of course preferred; and for the sandy soils, those which contain some clay along with the marl. The proportion in common use near Arney's Town, is from ten to twenty loads per acre. In other places five loads or even less is found to be sufficient. The action of the marl appears to be very permanent, as will be evinced by the following statement. In a large quadrangular field over which I walked, four successive applications of the marl had been made at intervals of four years—commencing about twenty years ago. The first dressing was applied to the north side—the second to the south—the third to the east, and the fourth to the west—while a small space in the centre, was left without any marl. All four sides were covered with a very heavy crop of clover, which was nearly, if not quite as luxuriant on the north as either of the other sides—while the space in the middle was almost bare. The action of the marl appears to be most powerfully felt by clover and grass—but it is very conspicuous also with small grain and corn. A very intelligent farmer told me that it more than tripled his clover and grass crop, and doubled his small grain. In general it is spread upon the clover every fourth year, and ploughed in for the next crop. That it is very efficient upon sandy soils is evinced by the following striking fact. Some years ago an en-

terprising farmer near New Egypt, purchased two hundred acres of the Pine Barren, which, by marling, he has converted into pasture sufficient for one hundred head of cattle. Such is the demand for the marl, even at a considerable distance, that it has become an article of great profit to the proprietors of the pits, and more than one individual was pointed out to me who had risen to wealth by the sale of marl.

From what has been stated it will at once be evident, that the discovery of extensive and accessible beds of this manure in Virginia would be a most important accession to the resources of the state, and that an active and diligent search ought forthwith to be commenced throughout all the region in which there is a probability that it exists. Every aid which it is in my power to give, will be cheerfully bestowed in furtherance of this inquiry: and as I feel the double interest of a scientific curiosity, and a sincere solicitude for the agricultural prosperity of our state, I shall gladly receive all fossils and other specimens which may be transmitted for inspection or analysis, giving them a prompt attention, and communicating in reply such hints as may promise to be most useful in this deeply interesting and important investigation.

WM. B. ROGERS.

*Extract from editorial remarks.*

Among the most valuable of these discoveries we believe will be found that of the *green sand*, announced in the communication of Professor Rogers in the first part of this number. We rejoice that this and other kindred subjects have been undertaken by an investigator having suitable scientific attainments, as well as zeal for the pursuit. This discovery is as yet but dawning, and the examinations of many persons guided by the directions given in Mr. Rogers' communication, may be usefully employed to aid him in the pursuit. These aids we earnestly hope will be afforded: and those who may offer them, will no doubt serve their own private interests, as well as that of the public, by such labors.

These latter remarks would have appeared better placed immediately after the piece to which they refer. But our silence then was caused by the expectation (which unavoidable circumstances have compelled him to disappoint) that the author would add the result of an examination of the stratum of "gypseous earth," which we have believed to be very similar to, if not identical with the *green sand* or *Jersey marl*. This examination will yet be made: and we feel confident that there, and still nearer the falls of the rivers, will be found in the greatest quantities the earth described as green sand.

From the Farmers' Register of May, 1835.*

*Further observations on the green sand and calcareous marl of Virginia.*

In a communication published in the 3rd No. of the Register, I announced the discovery of the green sand, or silicate of iron and potash, in the ordinary tertiary marl in Lower Virginia. Geological considerations, taken in connexion with this discovery, led to the inference that an older deposite, consisting in much larger proportion of this peculiar substance, would be found in a region more remote from the seaboard, and not far below the head of tide; and from the great agricultural value of this substance, as proved by the experience of the farmers in New Jersey, I was induced to point out its probable position, and to give such hints and directions with regard to its accompanying indications as might prove useful in any researches which might be undertaken by persons residing in the region in which it was supposed to exist. Since the publication of the paper referred to, as far as other engagements would permit, this important inquiry has been actively continued, not only in reference to the presumed deposite above mentioned, but also to the extensive calcareous formation of our lower counties.

Besides the practical importance of this investigation to the agriculture of a large district of the state, in a purely geological aspect, it was calculated to excite the highest interest. In the vast region of our tide-water country, at farthest, only two members of the *tertiary* group of formations had been hitherto discovered, and no decided indications of a *secondary* deposite likely to prove interesting to men of science, had been found. At the mouth of the Potomac, and at some other points, a deposite had been detected by Mr. Conrad of Philadelphia, which from the great predominance of shells of *existing species*, was regarded by him as belonging to the upper or *newer tertiary*. The same eminent conchologist by an examination of numerous fossils from York town, Suffolk, the James River, near Smithfield, and other localities, had clearly proved that this portion of the *tertiary* series was of greater antiquity than the former, and accordingly he has recently applied to it the title of *middle tertiary*—which, as some geologists in Europe divide the tertiary group into *four* periods, would include both the second and third of these subordinate formations. The *lower tertiary*, which Mr. Conrad had so successfully investigated in Alabama, had not as yet been brought to light within the limits of Virginia. Thus, therefore, these inquiries appeared fraught with the lively interest of scientific discovery, while at the same time they inspired the animating hope, that in some of their results, they might eventually be found conducive to the interests of an important district of the state.

From the great extent of the *middle tertiary* of Lower Virginia, it was to be expected that, notwithstanding the diligence and learning of those who had visited several of its interesting localities, with the view of studying its fossil contents, an extensive field of future discovery would be opened to the scientific explorer—and a great variety of new and peculiar fossils would be brought to light. To a certain extent this anticipation has been realized; and the occasional examinations which I have made in this vicinity, and at some remote points, have been rewarded by an extension of the list of fossils, and the discovery of a number of new and interesting species. To the readers of the Register, generally, the details of these observations would appear unimportant, if not useless, and must therefore be omitted. At the same time, I may be allowed to add, that such facts are frequently invested with a *practical interest*, by the aids which they furnish to other and more impor-

*This has received the author's corrections of some slight errors in the first impression, and others in his MS.

tant discoveries; and that, however little value, in the abstract, would attach to an enumeration and description of the shells, zoophytes, and other remains of our marl banks, they are absolutely essential in studying the physical history of this portion of the globe, and may prove of some assistance not only in guiding the researches of the farmer after marl, but in directing his choice of calcareous manure, when various deposites of this substance are offered for his selection. Of the latter point, several striking illustrations might be adduced—but I shall content myself, for the present, with the statement of a single fact. A small shell of rough exterior, and rather irregular form, a species of *chama*, is frequently found in very extensive beds in this vicinity and at other points, forming nearly the entire calcareous portion of the deposite. From its peculiar form and friable character, it is most generally in a condition to be eminently serviceable as a manure. As the strata both above and below are often of a very different texture, though perhaps nearly equal to it in regard to their calcareous contents, a choice is at once presented to the farmer, in which, he will be guided even more by the nature of the shell embedded, than by the comparative abundance of carbonate of lime. But so little attention has been paid to the characters of the fossils contained in our marl-banks, that even in places where the manure has been longest and most successfully in use, a less valuable stratum is sometimes selected in preference to one of superior fertilizing power. A more minute observation of such particulars, can scarcely be expected, in the absence of some popular guide, in the form of delineations and descriptions of the more prominent shells, exempted as much as possible from technical or merely scientific phraseology. Some such illustrations may hereafter be furnished in a cheap form in the progress of a geological examination of the eastern region of our state.

Since the publication of my former paper, a great number of additional observations have been made with regard to the green sand contained in our ordinary middle tertiary marl. Its uniform presence in this deposite, in a greater or less proportion, seems now to be sufficiently established. That it is *generally* present in sufficient quantity to enhance in any important degree the agricultural utility of the manure, it would be going much too far to assert; but that in many cases the proportion is such as cannot fail of producing highly beneficial effects upon vegetation, would seem to be demonstrated not only by the long experience of the farmers of New Jersey with the green sand itself, but by the observations of individuals amongst ourselves who have been in the habit of applying a calcareous marl in which this substance is peculiarly abundant. In the vicinity of Williamsburg, almost every variety of the common marl may be found; but that which has been observed to produce the most striking effects as a manure, has uniformly yielded to chemical examination a comparatively large proportion of the green sand. When therefore, it is in the power of the farmer to make the selection, such marl should be chosen, as, along with a large proportion of calcareous matter in a suitable state of subdivision, contains also as great an amount as possible of this auxiliary manure. The beds of *chama* already referred to, as abounding on some estates in this vicinity, are peculiarly rich in this ingredient, and are hence, as well as from their friable texture, generally selected in preference to all others. In some of these deposites, as large a proportion as thirty, and in some specimens forty per cent., has been found; and in cases like this, if we are to trust to the experience of New Jersey, a very marked addition to the fertilizing power of the marl must be ascribed to the presence of this ingredient.

In alluding thus to the influence of the green sand as an auxiliary manure, the inquiry naturally arises, to which of its ingredients are its meliorating effects to be ascribed, or do they arise from the conjoint action of the potash and oxide of iron which it contains? To this inquiry, perhaps, it would be premature to attempt to respond. At all events, the rationale of its action cannot be given with that certainty, which in such matters, it is desirable to attain. As stated in the former communication, its components are protoxide of iron, potash and silex; the latter ingredient appearing to act, as it is known to do in many rocks, in the capacity of an acid. In virtue of the potash contained in the green sand, we would naturally infer an agency in neutralizing acids, similar to that of lime, or its carbonate—and the extent to which the manure possesses this property, must appear still further increased when we advert to the chemical nature of the protoxide of iron.

Iron, like most other metallic bodies, combines with oxygen in more than one proportion. These compounds, or *oxides* as they are termed, are two in number, and in accordance with the general rule adopted by chemists in designating this class of substances, that which contains the least proportion of oxygen, is called the protoxide--that containing the most, the peroxide. The rust of iron, and the red coloring matter of ochreous clays, and of bricks and tiles, are impure specimens of the peroxide of iron. The protoxide is never found in an uncombined condition; and such is the avidity with which it imbibes an additional quantity of oxygen, or unites with carbonic and other acids, that it undergoes a rapid change whenever disengaged. Hence, under favorable circumstances, a strong neutralizing action might be anticipated from this ingredient of the green sand. We may therefore, for the present, rest our explanation of the agency of this manure upon the alkaline properties of these two constituents, the potash and the protoxide of iron. But in suggesting this explanation, it must be freely confessed that, especially as relates to the action of the protoxide of iron, it must be looked upon as problematical, and requiring for the establishment of its truth, an experimental knowledge of the influence of this substance upon the growing vegetable, of which nothing has as yet been positively determined.

As already indicated, when these inquiries were entered upon, and at the time when my first communication appeared in the Register, the existence of a *lower tertiary* deposite in Virginia had not been ascertained. The industry of Mr. Conrad had brought to light a formation of this nature in Alabama, and had led to the probable inference that it existed at Fort Washington in Maryland. Moreover one or two of the fossils obtained from the editor of the Register encouraged the hope that it might be found in our own state. The observations of that gentleman respecting the gyp-

seous earth of James River* had appeared some time before, and though nothing positive could be gained from them, in relation to the geological character of the deposite, to which he affixed that name, they threw out the important and sagacious suggestion, that this earth was the same with the green sand of New Jersey, or at least a substance of analogous character. We shall in the sequel, learn that though geologically the two formations belong to periods which are distinct, the gypseous earth contains a large proportion of that particular ingredient, (the green silicate of iron and potash,) of which the New Jersey deposite almost exclusively consists. We are therefore indebted to the editor of the Register, for the announcement of the important fact, that the green sand, or a substance analogous to it, existed in certain localities on the James River.

Following up the suggestions of geological analogy, alluded to in my first paper, and stimulated by the observations and statements of Mr. Ruffin, I have been enabled by personal inspection, and through the kindness of correspondents, to ascertain with certainty, the existence of a *lower tertiary* deposite, throughout an extensive district of Eastern Virginia, and moreover to determine what is far more important to the agriculture of this region, that the deposite in question comprises immense strata of green sand, perhaps nearly equal in value to that which is in use in New Jersey. The reader, however, is by no means to infer from the existence of the green sand so abundantly, both in this lower tertiary and in the New Jersey formation, that the two deposites belong to the same geological era. I have already stated that the New Jersey green sand, is a *secondary* deposite—and of course anterior to the formation here designated as lower *tertiary*. The shells and other fossils, entombed in the two deposites are strikingly different, and characteristic of difference of geological antiquity. As it is desirable that clear ideas should be entertained, in relation to the distinction here drawn, I would claim the indulgence of the reader, in presenting such explanations, and illustrations, as are calculated to throw light upon a subject in which, at least in some particulars, all are obviously interested.

The term *primary* having been adopted by geologists as designating that extensive class of rocks which from various indications, appeared in general to have originated *first*, and which are destitute of all traces of animal or vegetable existence—the title of *secondary*, was of course appropriated to a class, apparently of more recent origin, usually overlying the former, and in which, in many cases, an enormous accumulation of organic remains had been discovered. A minute examination of these remains, consisting of shells, the bones of animals, &c., disclosed the curious fact that they belonged to races of beings of which, at present, there are only very few living representatives. Subsequent observations, first systematically made by Cuvier and Brogniart in the vicinity of Paris, further demonstrated that overlying the secondary formation of that region, there existed an extensive series of deposites of great thickness, the fossil contents of which were, on the whole, very dissimilar from those of the former—not only *all the species*, but many of the most remarkable animal and vegetable forms being distinct, while at the same time many of the species were observed to be identical with others now alive. The difference thus marked between the two series of deposites, uniformly prevailing wherever they were observed, led to the introduction of the term *tertiary*, to designate the upper and more recent. By scrutinizing in detail the tertiary series, it was soon discovered to consist of several distinct subordinate formations, characterized by peculiar fossils, and becoming more assimilated in their organic contents to the existing living world, in proportion as their position in the series approached nearer and nearer to the surface. The most recent systematic writer on geology, and one of the most learned and able geologists of the day, has distinguished four subordinate formations in the tertiary series—and has given to each a specific name, expressive of its relative period of deposition. Though unwilling to perplex the reader with the terms of science, I may perhaps be excused on this occasion for introducing the names here referred to, on the ground that they are likely to be met with frequently hereafter in geological descriptions of the tertiary deposites of this country—and as they are distinctive of *things* which are characteristically different, and which have received no other denominations so appropriate, they have a just claim to be received. The terms thus employed by Mr. Lyell, the distinguished geologist above alluded to, are—

1st. *Pliocene*, indicating a *majority* of the contained fossils to be *recent*, and divided into *newer* and *older* Pliocene. Under this head are comprised some of the shell deposites near the mouths of our rivers.

2nd. *Miocene*, indicating a *minority* of the contained fossils to be *recent*. To this formation belong most of our calcareous strata which have previously been referred to under the title of middle tertiary.

3rd. *Eocene*, signifying the *dawn;* indicating the presence of a few fossils analogous to living species, or in other words a dawning of that condition of the animated world which now prevails. Examples of this are furnished in the lower tertiary of Alabama, and the lower tertiary here alluded to as recently discovered in Virginia.

The nature of the materials in which the fossils of these different deposites are embedded is very various. Sometimes the formation is a soft sand or clay—sometimes a sandstone or limestone of comparative hardness. In some cases the deposition appears, from the nature of the fossils, to have been made beneath the ocean—sometimes at the bottom of an extensive lake. In the vicinity of Paris, there are three marine formations alternating with two of fresh water or lake origin; and from one of the latter, the celebrated gypsum or plaster of Paris is extensively quarried. In Virginia, no traces of a fresh water tertiary have as yet been discerned. The general direction of the deposite is horizontal, and the whole appears to have been formed at successive eras beneath the waters of the ocean.

From what has now been said, it will at once appear that strong features of resemblance are presented in the geology even of the more recent formations in this country and Europe. The most striking similarity exists between the secondary of New Jersey and that of many places in Europe—

*Article on "Gypseous Earth," page 105.

as far as fossil contents are concerned. But in Europe a great proportion of these fossils are embedded in chalk; whereas, in New Jersey, no chalk has been discovered, and its place is occupied by green sand, very similar to that, which, in the former localities, alternates with the layers of chalk.

The lower tertiary or eocene of Virginia is found in a band of variable, and as yet unascertained breadth, traversing the state nearly in a direction from north to south. It makes its appearance on both sides of the Potomac, in a line a little east of Fredericksburg. It then crosses the Rappahannock near Port Royal, the Pamunkey probably near Piping Tree, and the James River at Coggin's Point. With regard to its course further south, though its existence is probable, additional data are required.

In general character, this formation may be thus described. At the base of the cliff or bank, there usually exists a stratum of what at first sight appears to be a blue or black clay, but which, on further examination, is found to consist principally of particles of the silicate of iron and potash, which when dried, becomes of a lively green color. Mingled with this substance are portions of common clay and sand, and numerous minute shining scales of mica. Embedded in the mass, and usually in a very friable condition, numerous shells chiefly of small dimensions will be found. Sometimes however, the matter of the shell has entirely disappeared, leaving a distinct cast or impression in the earth, by which its specific character may often be ascertained. Immediately above this stratum is a heavy deposite of what Mr. Ruffin has described as gypseous earth.* Large masses of crystalized gypsum, and sometimes the most beautiful groups of perfect crystals of this substance, are disseminated throughout this layer. It was this portion of the formation which Mr. Ruffin conceived to be identical with the green sand of New Jersey. In color, this stratum varies from a greenish yellow to a brown. Besides a considerable proportion of green sand, it contains, in addition to the crystalized gypsum, a notable amount of this substance in a subdivided state, and seemingly occupying the place of the shells which were formerly present, and have been decomposed under the chemical agency of some substance which filtrated in solution through the mass. Incumbent upon this bed is a thin layer of very pure white clay, of a texture which would recommend it to various useful purposes. Overlying the clay in some places, is a stratum of shell marl in a very subdivided state, containing masses of casts and shells approaching to the hardness of rock. This is the uppermost layer of the eocene or lower tertiary formation. Yet at some points a stratum of the ordinary middle tertiary marl rests almost immediately upon the former, and would not by an ordinary observer be recognized as distinct. At Tarbay, where this succession of strata was observed, a thin and scarcely distinct layer of small brownish red pebbles intervenes between these two layers of shells, seeming to mark a comparatively violent action of the waters in the interval of the two deposites. But an examination of the shells, in these two contiguous strata, affords abundant evidence of their belonging to distinct geological epochs. In the upper stratum the large scallops, the common oyster of our marl, and all the usual ingredients of our middle tertiary or miocene formation, may be recognised. In the lower bed few or none of them exist, but certain characteristic shells belonging to the eocene period are entombed. Similar fossils appear below, in the green sand beneath the gypseous earth; and here a great variety of beautiful specimens may be discerned. An enumeration of these fossils in this place would of course be attended neither with utility nor interest, and indeed, were it advisable in the present stage of the inquiry, it could not be made, on account of the necessity of comparing the specimens with shells from other localities in Europe and this country, in order to identify species, and to decide upon those which are new, or peculiar to our own formation. That many such exist, I have every reason to believe, and with future leisure it is hoped that they will be named according to the fashion of the day, and described in the appropriate place. It will however be of real value to the reader, in any inquiries which he may institute, in reference to this formation, to obtain some general idea of the characters of two or three of the more conspicuous and characteristic shells. The observer will perhaps be able to recognize the following:—

1st. The *cardita planicosta*. This shell is of various sizes, rarely however equalling that of the clam. In form it bears some resemblance to that shell; but on the convex side a number of flattened ridges run from the knobbed extremity near the hinge, spreading from each other and enlarging as they approach the margin. The hinge part of the shell is very thick. This shell, occurs abundantly in the eocene or lower tertiary of Europe, and also in that of Alabama.

2nd. *Ostrea sellæformis*, or saddle-shaped oyster. This shell is very peculiar, having, when full grown, such a lateral extension on each side as to present, when the hollow of the shell is turned down, a very distinct resemblance to a saddle with its two depending flaps. It is found abundantly in the eocene of Alabama.

3rd. *Fusus longaevis*, a small shell less than an inch in length, and resembling in general form, those which are commonly called conchs. It is however flattened down on one side as if it had been subjected to pressure. This shell occurs abundantly in the eocene of Europe—but I believe has not until now been discovered in the corresponding formation of this country.

These three fossils, which are all found in great numbers in such of the eocene localities in Virginia as I have examined, are sufficient to identify the formation wherever they may be discovered. But as already indicated, they are accompanied by a variety of other shells, a large pro-

* The term "gypseous earth," used in the article referred to above, was applied not to a part, (as here supposed,) but to the whole of that formation which Mr. Rogers has since shown to be of "green sand." But it was also stated, that by the general application of that term to the extensive beds which seemed to have had a common origin, (and formerly, the same chemical composition,) it was not intended to convey the opinion that all this earth contained sulphate of lime, either in crystals, or finely divided. On the contrary, that ingredient was said not to be present, in any perceptible quantity, in but very few parts of the great body of what was there called "gypseous earth."—See Farmers' Register, Vol. I. p. 208.—Ed.

portion of which, would appear to be peculiar to this particular region. It would seem that the eocene of Virginia though agreeing in most respects with that of Alabama, contains some fossils found also in the Paris eocene, and which are absent from that of Alabama.

In most of the specimens of marl from this region hitherto examined, besides a large amount of green sand, I have found a considerable proportion of gypsum, and in some of them as much as forty or fifty per cent. of carbonate of lime. Specimens received from Dr. Corbin Braxton, at the Piping Tree, were found to contain, along with much green sand, a great amount of the carbonate of lime, and some gypsum. Judging from its composition and texture, it must be looked upon as a very valuable manure. At Coggin's Point, the lower stratum before described, contains from sixty to seventy per cent. of the green sand, with a small proportion of carbonate of lime, and occasionally a little gypsum. The next deposite above, (the gypseous earth) abounds in gypsum, but contains less green sand than the former. Of this ingredient, however, it still possesses a very considerable proportion. In alluding to the powerful effects of the gypseous earth, in a trial which he made, the author of the *Essay on Calcareous Manures* describes them as much greater than could be accounted for by the proportion of gypsum present, and hence throws out the suggestion that some other fertilizing ingredient was contained in the earth. This additional effect must doubtless be ascribed to the presence of the green sand.

In prosecuting the geological survey of Maryland, Professor Ducatel has been enabled to ascertain the existence of a green sand deposite throughout an important district of that state. Of its existence on both sides of the Potomac I was already fully aware—and it affords me much satisfaction to find that the suggestions based upon general geological considerations, which were presented in my former paper, have already been so actively and ably followed up by this enlightened and diligent observer. Of the identity of some of the green sand deposites described in his report, with that now ascertained to exist in the eocene of Virginia, I am as yet by no means convinced; but a minute geological examination, such as that already instituted in Maryland, and that which is looked to with some interest in Virginia, cannot fail to throw very useful light on this, as well as all the other important deposites in the tide-water region of the two states. Mutual benefit would arise from the co-operation of surveys, conducted at the same time in the two adjoining territories, and in this way the interests of the states, as well as those of science, would be most effectually and speedily promoted.

To the very meagre details, in relation to the green sand, presented in this communication, I may hope ere long to be enabled to add the results of extensive and minute personal observation in the interesting region in which the eocene formation has been detected. In the mean time, the progress of inquiry may be greatly furthered by the friendly aid of those who, from their residence in the region in question, will have it in their power readily to collect specimens of shells or earth, and to transmit them to me for inspection. I would therefore, earnestly solicit assistance of this kind, and in return, I will gladly communicate the results of any observations I may be thus enabled to make. To urge the importance of this, and other similar inquiries, would now no longer seem to be necessary—since a large portion of the intelligence and enterprise of our state appears prompt to recognise their value, and interested in furthering their active and successful prosecution.

WM. B. ROGERS.

## ERRATA.

Page 4, in date of preface, for "1834" read "1832."

5, at the end of the advertisement to 2d ed. insert date, "*April* 1835."

19, col. 1, 14th line—for "*forty-seven*" read "*fifty-seven.*"

49, col. 1, line 47, after "*Appendix H.*" add "*and S.*"

68, col. 2, line 60, for "*Appendix P.*" read "*Appendix E.*"

81, col. 2, 1st line of the note—for "*translation,*" read "*transition.*"